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Engineering and Mining Journal

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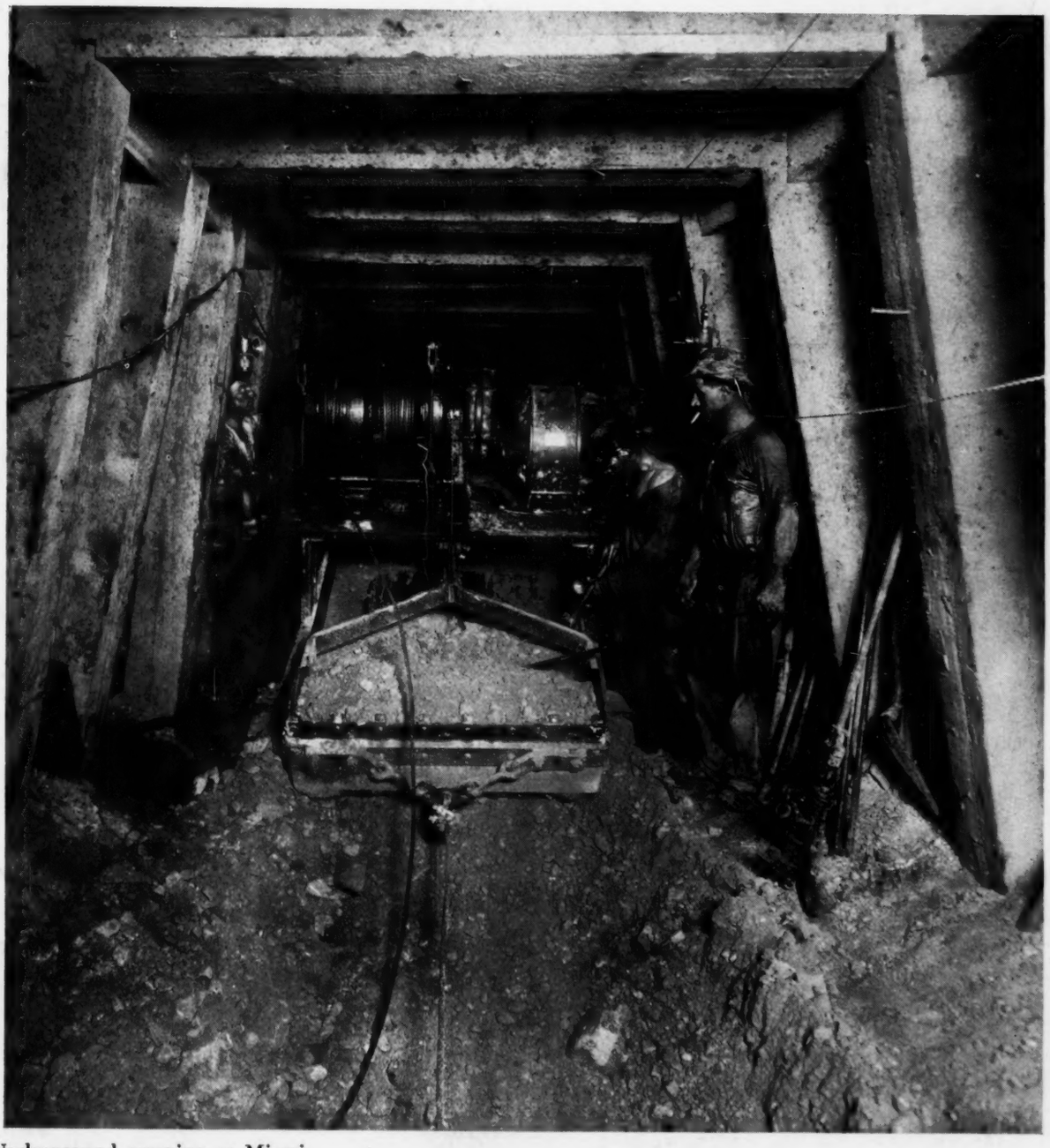
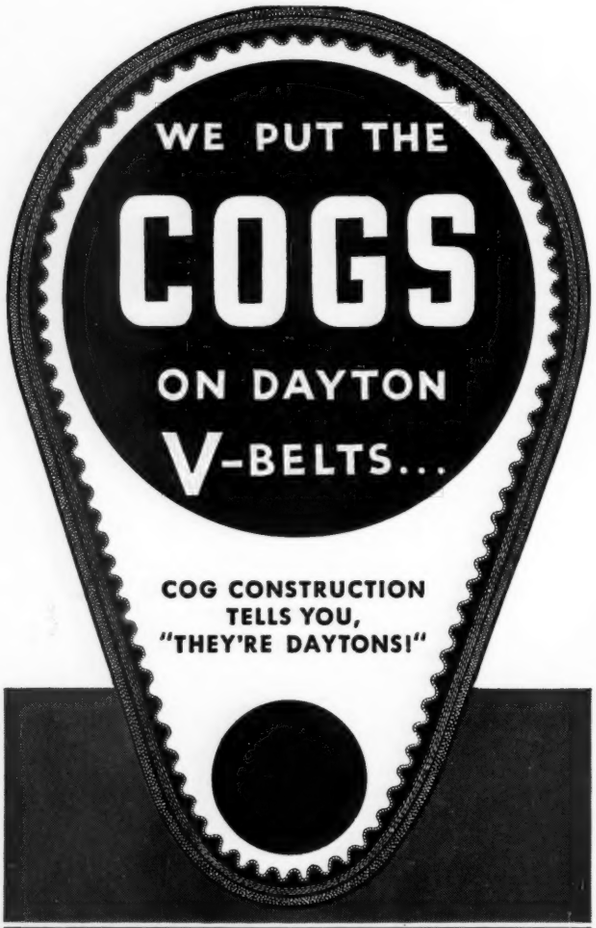


Underground scraping at Miami

July 13, 1931



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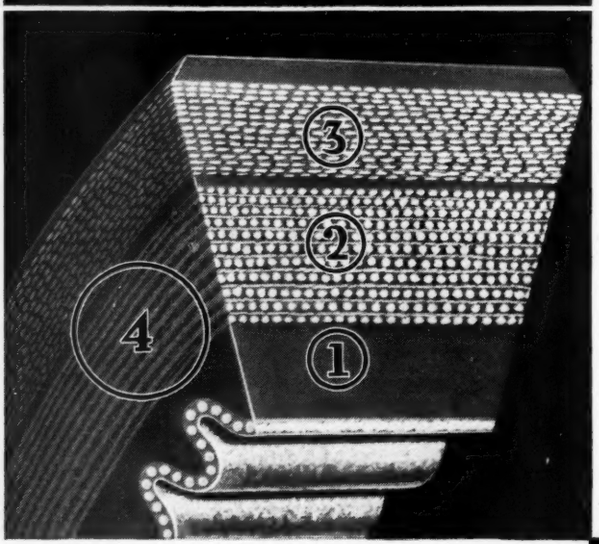

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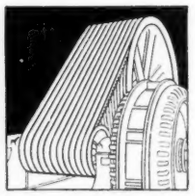

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A. W. ALLEN, *Editor*

San Francisco
GEORGE J. YOUNG
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Assistant Editor

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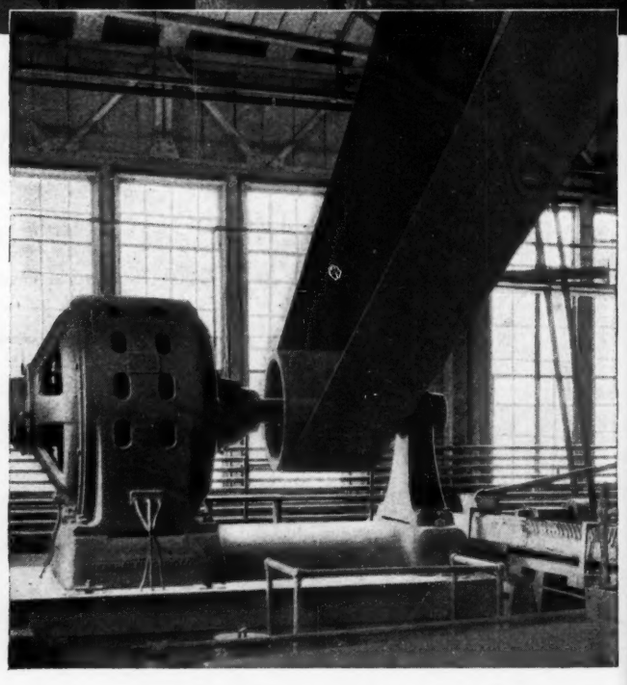
Two Decades *of*

Regrinding plant of Calumet & Hecla Consolidated Copper Co., Calumet, Michigan, showing the double-row of 64 G-E motors—each of which has been in service for nearly 20 years—not one of which has ever burned out



One of eight G-E 250-hp. motors driving conical mills and jigging tables at the No. 1 grinding plant

Engineering and Mining Journal

July 13, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 1

Manhattan Mining Dust Hazards

CHARACTERISTIC of a large city is a contempt for danger and an indifference to health hazards. This is particularly true in regard to conditions directly favorable to the contraction of silicosis, a disease caused by the inhalation of silica dust. Every construction job on the island of Manhattan attracts the casual or sustained interest of citizens who appear to represent an average cross-section of the population; yet none seems to appreciate the facts or to be disturbed because the rock-drill worker operates in a cloud of silica dust and so is doomed to ill health, perhaps to an early death from a wasting disease. The number of men exposed to the danger totals at least 20,000 per annum in this one comparatively small area.

Early in 1929 the *Journal of Industrial Hygiene* reported the results of a medical study of rock-drill operators in Manhattan. Fifty-seven per cent were found to have contracted silicosis and 9 per cent were tuberculous. Conditions have been steadily growing worse, because of the absence of preventive action. The *Journal* adds that " . . . the workers, particularly the rock drillers and the blasters, are generally aware of the industrial hazard to which they are exposed. If there is any unanimity of opinion among them, it might be expressed by the statement that they feel that if they remain in the occupation long enough they will end by dying of tuberculosis. They are not aware that an exposure of even a few years may have deleterious effects, though they fully realize that measures for their protection have not been taken."

This deplorable condition, one is glad to be able to report, may be radically improved in the future, thanks to one of the engineers of the George J. Atwell Foundation Corporation, Mr. George S. Kelley, who has invented a dust separator for rock drills that has satisfactorily passed preliminary tests. One machine is designed to collect from 60 drills. The dust is drawn into a pipe, passing thence through a main to a special apparatus, in which a water spray effects the final removal of fine particles from the air. Although primarily designed to protect the worker from a hazard to health, the innovation will prove to be good business for the contractor in terms of footage drilled, because the machines can henceforth be operated at maximum power, whereas formerly the pressure had to be throttled to prevent dust conditions the seriousness of which would have inhibited work altogether.

The invention is the outcome of the efforts of a representative advisory committee appointed in 1929 by the New York State Industrial Commission. The experimental apparatus was constructed at the expense of the Metropolitan Life Insurance Company, as a part of its program to improve general health conditions. To all concerned is due credit for initiative and action in a serious attempt to remedy a condition that advertised an apparent disregard for elementary humanitarian principles and business common sense. How many mines producing ore would be open to the same criticism if their operations were as public as are the excavations on Manhattan Island?

Historical Summary

Engineering and Mining Journal was founded in 1866 as the *American Journal of Mining*, the title being changed in 1869. Publications absorbed comprise: *Coal and Iron Record* (1875); *The Mining Review* (1877); *The Polytechnic Review* (1879); *Mining and Metallurgy* (1902); *The Mining Magazine* (1906); *Mining and Engineering World* (1917).

The following have served as editors in chief of *Engineering and Mining Journal* and its predecessor publication: G. F. Dawson (1866-67); R. W. Raymond (1867-74); R. W. Raymond and R. P. Rothwell (1874-89); R. P. Rothwell (1890-1901); D. T. Day (1901-02); T. A. Rickard (1903-05); W. R. Ingalls (1905-19); J. E. Spurr (1919-27); A. W. Allen (1927-).

Engineering and Mining Journal was consolidated with *Mining and Scientific Press* in 1922, as *Engineering and Mining Journal-Press.* The title was changed to *Engineering and Mining Journal* in 1926.

The editorial staff of *Engineering and Mining Journal* comprises: A. W. Allen, editor; E. H. Robie, George J. Young, A. H. Hubbell, associate editors; W. N. P. Reed, H. D. Keiser, S. D. Strauss, J. B. Huttl, B. H. Strom, assistant editors; H. H. Wanders, market editor.

Issued twice each month

New Producers and the Consumption Factor

SEVERAL important properties, on which development and construction have been under way during the last few years, have entered the ranks of producing non-ferrous metal mines in recent months. Among these are Roan Antelope, the pioneer large-scale producer in Northern Rhodesia, expected to be the forerunner of at least five large copper mines; Mount Isa, with known reserves larger than in any other single lead-zinc property; Sherritt-Gordon, a sizable copper-zinc project in northern Canada; and Wiluna Gold, destined to be at least temporarily the largest gold producer in the famous Western Australian field. Still other properties approach the day when their crushers will first begin to handle large tonnages of metal-bearing ore.

Each one of the properties cited has called for the investment of several million dollars. It has demanded the exercise of technical skill, brought together from the ends of the earth to design and erect equipment that will perform its task efficiently from the time the first skipload of ore is hoisted. Gone are the days when a new property worked out its flowsheet haphazardly in the first years of operation. The mines of today are so large, and the margin of profit on which they are expected to operate is so small, per unit of ore, that mistakes must be avoided from the start. Experience and research must solve the technical problems before the first wheel turns.

From the standpoint of the economics of the industry, the entry of these giant new producers must be regarded with mingled feelings. New gold producers, in a civilization where gold is the only constant, are, of course, to be welcomed. But what is the lead producer to say to Mount Isa, the copper producer to Roan Antelope? To the rest of the base-metal industry, their entry must seem inopportunely timed, the result of a whimsical fate—or is it a planless civilization?—that prefers not to divulge its course in advance. This much, at least, is there of cheer: low prices are not necessarily the concomitant of poverty. Consumption is a more important factor in many respects than price.

Reducing the Blasting-Cap Hazard

THE campaign conducted by the Institute of Makers of Explosives to prevent injuries that are caused by playing with blasting caps deserves wholehearted support. Many hundreds of children are killed or crippled every year with these dangerous toys, picked up where blasting is being done. Mangled hands, disfigured faces, sightless eyes are among penalties imposed upon the innocent victims of the negligence of operators.

Statistics compiled by the Institute show that most of these accidents occur in rural districts, where children have more opportunity to play along highways and in the fields. Another important fact disclosed is that, beginning with the month of March, these accidents become more and more frequent, until a peak is reached during the summer months. Year after year, with unceasing regularity, the curves tell their grim tale.

No opportunity should be neglected to impress upon children the dangers to which they expose themselves when playing with explosives, with even such a harmless looking object as a small shiny copper cap. Children, however, are inclined to let such admonitions pass unheeded, a fact that adults should bear in mind. To many children the knowledge of hazard adds zest to the play, making possession of explosives the more attractive.

With the users of such explosives, therefore, rests the chief responsibility. If the blasting operator would exercise care to prevent the miscarriage of live explosives, little else would be required. During the approaching summer season, when the hazard is greatest, extra vigilance is needed.

Re-treatment of Residue Dumps

THE owners of the immense dumps of nitrate residue in Chile have been gently but persistently baited to show cause why the successful history of residue re-treatment in the metallurgical industries should not be repeated. An initial objection insisted that the material, scattered throughout the nitrate region in convenient piles, was untreatable—a contention that was controverted by proof to the contrary, proof that can be substantiated by any individual willing to make a few tests and not averse to the disclosure of facts. The question of economics was then raised, in discouragement of initiative in this connection, and the claim made that the amount of nitrate in the dumps was insignificant. Against this argument was brought recognized and accepted data proving an output of about 100 million tons, values at about four thousand million dollars in the century during which the Shanks process operated, at an efficiency of certainly not more than 65 per cent. Even assuming an extraction of 75 per cent, or the mysterious loss of the difference in amount indicated by the two figures, however, a simple calculation shows that a vast amount of valuable product is unaccounted for, constituting a reserve that is recoverable by simple and inexpensive treatment methods.

For many years the statement seems to have passed undisputed that no single large dump of nitrate residue in Chile had been sampled. Now Dame Rumor disputes this conclusion, in regard to one dump at least. Details are lacking; those who made the experiment are extremely reticent in regard to operating data. What procedure was followed? Gossip has it that a tunnel was driven, with discouraging results. Again one can almost hear the sighs of relief. The great piles of residue, aggregating hundreds of millions of tons, like the Sphinx of Egypt and the Pyramids, may be allowed to hold their secrets. The world surely will accept as fact the conclusion that the exteriors hide only negligible amounts of nitrate and iodine. Or the present may not be an opportune time for optimistic reports. The reader can decide which alternative is the more plausible.

History, however, has a disconcerting way of suggesting that circumstantial parallels often provide the basis for a determination of factual parallels. The Chilean nitrate industry is not alone in having treated

high-grade raw material, with poor technical recovery. Early in the 90's, for instance, when the cyanide process was in its infancy, a plant in the Lydenburg district of the Transvaal, in South Africa, was erected to treat a gold ore that was worth $50 per ton. Recovery, by the crude leaching methods then in vogue, was about 70 per cent; and the residue, proved by routine assay to contain about $15 per ton, was stacked. A year or so later the question of re-treatment arose, whereupon the owners found that the gold content of the dump had mysteriously shrunk to $9 per ton. As the loss could not be attributed to the depredations of *camenchaca* birds or other mythical animals that fly to the rescue of the harassed technical accountant in Chile, the simple and logical step was taken to sample the ground on which the dump rested, with the result that it was found to assay $38 per ton. Needless to say, the rich stratum was treated, after mixing with the dump material, and a satisfactory profit resulted.

Gold ore carrying less than $2 per ton is being profitably mined and beneficiated today by a simple hydrometallurgical process under experienced and competent direction, after the exercise of a care and frugality in capital expenditure for research and plant equipment that kept the economic goal in view in all stages of promotion and development. Other mineral industries may yet find opportunity for low production costs in the adaptation of some of the basic features of the cyanide process, particularly in regard to bulk leaching —as technically sound and adequate a method in its fundamental features as it was when successfully applied in the early days of the introduction of the MacArthur-Forrest invention, to be borrowed later and used so successfully by the copper industry.

Technologic Unemployment of Commodities

RESEARCH and investigation, which are upsetting many standards that have been considered permanent, are themselves inducing more research and more investigation, to counteract the ill effects of diminishing markets. These comments are prompted by a recent development in the insulation of electric wire, whereby paper is likely to displace cotton to a considerable extent, resulting in an economy of space, weight, cost of material, and manufacture. Such tendencies cannot be checked so long as competition is spurred by lowering prices; and the only hope for survival lies in production economies, increased output, and accumulation of stocks, which in turn ends in price reduction below the economic limit by those companies financially prepared to meet the loss involved. Thus is a premium put on the virtues of foresight and provision.

The philosophy of war has been injected into business by the encouragement of ruthless competition and price paring, in which the ultimate consumer is the last to detect advantage. The tendency is as bereft of benefit to all concerned as is war itself; but it is highly recommended by those legal and military elements who profit by conflict, and who exert so powerful an influence on legislation and public opinion.

Acid as an Aid in Technical Analysis

THE component parts of a specimen must be contrasted if differences are sought. Westinghouse engineers have applied this principle to maximum effect in analyzing the comparative value of electric welds, and in determining the suitability of welding-rod material. Prepared sections of the welds are treated with acid. The weakness or strength of the union is immediately made apparent.

At the Missouri Bureau of Geology and Mines an equally ingenious application of the fundamental idea is in use as an aid in the geologic analysis of rock. Specimens of limestone showed a baffling similarity, although ancestral and environmental influences were obviously widely divergent. Sharp contrast was effected by a preliminary treatment with hydrochloric acid, whereby the calcareous matrix was dissolved. From such simple beginnings are sometimes developed an elaborate and comprehensive technique of analysis.

Forced Lubrication Without a Pump

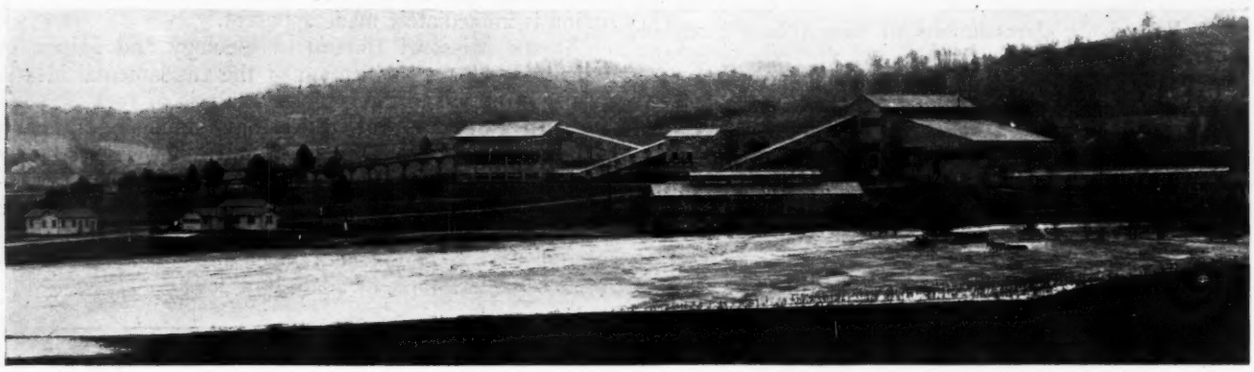
INFINITE OPPORTUNITIES for producing new phenomena seem to be at hand, even if the secondary definition of the word be used—"that which strikes one as strange, unusual or unaccountable." When an engineer is confronted with a description of something that appears unreasonable, the immediate reaction is that of skepticism. A demonstration may convince, but he is not fully convinced until the phenomenon is capable of an explanation that satisfies the demands of logic and common sense and natural law.

Sometimes an adequate and satisfying explanation is still wanting, albeit recognition of successful performance cannot be denied. This applies to a system of bearing lubrication devised a few years ago by Mr. J. D. Jones, an engineer well known in the mechanical industries of the northwestern states. The bottom casting in the journal forms a reservoir for the oil, into which dip several fins through which oil passages are drilled, connecting with the bearing metal. On rotating the shaft, a pumping action is produced. A strong suction results, and the oil is drawn up through the passages to the bearing surfaces, to be spread across the width of the bearing by longitudinal slots at the junction of base and cap, with return ports which serve to carry excess oil back to the reservoir.

The pumping action is positive, and the circulation of the oil is evident. Pressure to produce this action may be caused by a vacuum induced in the space originally occupied by air between shaft and oil, by reason of minute depressions on the shaft. Suffice to say that the unexpected occurs and is put to good purpose.

As soon as the phenomenon of oil circulation in Mr. Jones's bearing is satisfactorily explained, the operation will become commonplace and will cease to excite scientific interest. The development emphasizes the importance of an open mind in an evaluation of what appears at first sight to be an unaccountable reaction.

Crushed-Stone and Ore-Dressing Plant —A Profitable Combination



Part of the plant of the Universal Exploration Company, at Jefferson City, Tenn. At the top left is the crusher building; to the right, the mill building; and in the center, connected with the other two buildings by conveyors, is the screening building. The slime pond is in the foreground, and on the far side of it is the machine shop and storage building. To the left are the office, laboratory, and first-aid buildings.

H. D. Keiser

Assistant Editor

FEW achievements in the mining industry can be compared, as expressions of sheer creative engineering ability, with the operations of the Universal Exploration Company, at Jefferson City, Tenn. To select the most important of numerous unusual features is difficult, but perhaps the extent to which foresight has been exercised throughout the entire enterprise may be justly singled out as being particularly impressive. For instance, the crushing and screening units of the milling plant are so arranged, and the underground operations so planned, that readily marketable crushed stone and zinc ore can both be produced with the same equipment in any respective quantities desired. Moreover, the concentrator is almost entirely automatic in operation. This has been accomplished largely by insuring constant and uniform feed to the various units and by using equipment of ample capacity. Remarkable simplicity—invariably an indication of engineering excellence—seems to characterize every phase of the company's operations.

The property, comprising about 1,200 acres, is situated on a 1½-mile spur of the Southern Railroad that connects with the main line at Jefferson City. Orebodies on the tract occur in the Cotter and Jefferson City formations of the Knox dolomite—a Cambro-Silurian sediment. Confined to an area of strong dolomitization and brecciation, and controlled by systems of joints and fractures, the orebodies have an irregularly broken course, extending down the dip for an undetermined distance and raking in a southeasterly direction. The strike of the formation is about N. 30 deg. E., and the dip 3 to 5 deg. Numerous deviations from this strike and dip are caused by folding and faulting. No major faults, however, occur in the orebodies, but rather a number of minor thrusts that vary in magnitude from a few inches to 6 ft.

The deposit is a replacement in limestone, with the ore minerals also filling interstices in brecciated dolomite. In shape, the deposit is blocky, consisting of ore blocks within parallel sets of joints (see Fig. 1). Thickness of the ore varies up to 80 ft. The ore is lead-free, the chief ore mineral being zinc blende. Small amounts of cadmium occur in the ore, as well as traces of pyrite, on the edges of the orebodies. The ore rocks are of three types: (1) fine-grained brecciated gray dolomite, (2) recrystalline gray dolomite, (3) dove-colored limestone. Cherty siliceous dolomites comprise the footwall.

Operations on the tract, begun in August, 1928, have been confined to the Davis orebody, which deposit occurs on the Davis farm portion of the property. Prospecting was done by diamond and churn drilling. Three prospect shafts, Nos. 1, 2, and 3, were sunk at selected points along the orebody. Development drifts and crosscuts, totaling 3,300 ft. in length, and so arranged that they could subsequently be used in extraction operations, were then driven to confirm prospecting results and to determine characteristics of the orebody. A geologic record was kept, round by round, of the disclosures in each drift and crosscut. Three levels were established, an upper or 1,172-ft. level, an intermediate or 1,146-ft. level, and a lower or 1,085-ft. level, the elevations assigned to each being based on a sea-level datum plane.

On completion of prospecting and development, No. 4 shaft, the main hoisting shaft, was sunk outside the orebody. This is a three-compartment, vertical

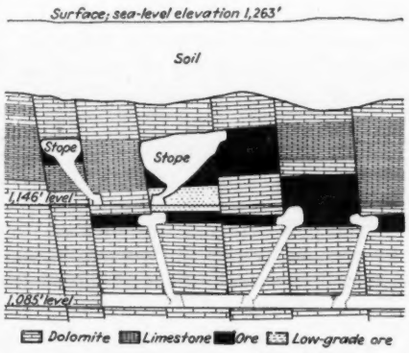


Fig. 1—Section through central part of the Davis orebody showing faulting and method of mining

shaft, 209 ft. deep, extending beyond the 1,085-ft. level, which is 178 ft. below the collar of the shaft. It consists of two 5x6½-ft. hoisting compartments and one 3-ft. 8-in. x 6½-ft. manway. Hoisting equipment comprises a Hardie-Tynes double-drum hoist, with 60x26-in. drums and Lilly control, and a 100-hp. G.E. squirrel-cage hoist-operating motor. Owing to the shallow depth of mining, rope speed in the shaft reaches a maximum at 550 ft. per minute.

Both underground and open-cut mining are carried on simultaneously. The open cut, situated just beyond the ore and waste-rock bins at No. 4 shaft, and inclosing No. 3 prospect shaft within its periphery (see Fig. 2), is about 225 ft. wide and 400 ft. long at the surface. After the 40-ft. layer of clay overburden was removed with a steam shovel, raises were driven through the ore from the 1,146-ft. level. The ore is benched or "milled" into these raises, as well as into the opening that comprised No. 3 prospect shaft, forming funnel-shaped openings, as shown in the two views of the open cut in Fig. 3. On the 1,146-ft. level, the ore is drawn through chutes into cars and hauled to the main hoisting shaft.

Underground stoping operations in the other sections of the mine consist of those on the three main levels and those on sublevels, which are reached by raises driven from the main levels (see Fig. 1). Breast stoping and benching, with hand shoveling, are employed on the main levels, pillars being left as required. On the sublevels, the ore is benched directly into the raises, whence it is drawn through chutes into cars. In breast stoping, the usual drill round consists of twelve 10-ft. holes, spaced at 2-ft. intervals in three horizontal rows, of four holes each, 4 ft. apart. Ingersoll-Rand N75 and Chicago Pneumatic CP6 drifters, mounted on columns, are employed. The round used in benching operations comprises nine 6- to 10-ft. holes, spaced at 3- to 4-ft. intervals in three parallel rows, of three holes each, 3 ft. apart. Gardner-Denver 871 sinkers, as well as the aforesaid drifters unmounted, are used for drilling the round. In drifting, a 23-hole round, 8 ft. deep, is employed. This round includes the Ballew cut, with "burn-out" holes, which has already been described[1] by F. L. Ballew, mine foreman at the property, who developed the round. Main haulageways are driven 8 ft. wide by 7 ft. high, and development drifts 6 ft. wide by 7 ft. high.

Ore is transported from the chutes in the raises, and from the stopes on the main levels, in ore cars of special design (see Fig. 4), made by the Lorain Steel Company. These cars have a capacity of 35 cu.ft. and hold 1¾ tons of ore. They are of the round-bottom, solid-end type, and weigh 2,000 lb., empty. The 14-in. wheels are equipped with Timken roller bearings. Trips of two cars are hauled by mules over 24-in. gage, 20-lb.-rail haulage lines to the shaft stations, where the cars are hoisted in cages to the platform above the one waste-rock and two ore bins that adjoin the shaft on the surface. Waste rock is similarly transported underground and hoisted in 1-ton end-dump cars, the 14-in. wheels of which are also equipped with Timken roller bearings. The design of the ore and waste-rock cars includes couplers. Both types of cars may therefore be hauled in the same trip.

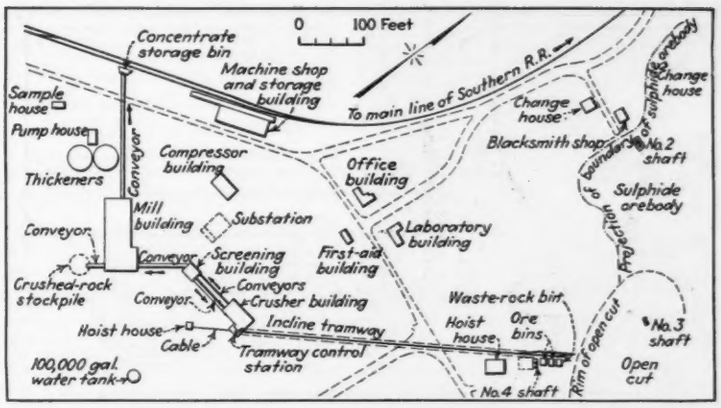


Fig. 2—General surface plan of the company's operations

Ventilation is largely natural, with No. 4 shaft downcast and No. 1 upcast. In the winter a flow of 23,000 cu.ft. of air per minute prevails in the main haulageways. Supplementary ventilation through the principal workings is provided as required by a Ventair TM-6 Coppus blower, driven by a 5-hp. G.E. squirrel-cage motor, operated at either No. 1 or No. 2 shafts. In addition, air is forced into development headings through 7-in. churn-drill holes by portable blowers, operated on the surface by 3- to 5-hp. direct-connected motors.

The quantity of water flowing into the mine varies from 40 to 250 g.p.m., depending on the season of the year. This fluctuation prevails because the 60-in. average annual rainfall of the district, most of which precipitation takes place in the spring and summer, percolates directly into the subsurface strata, surface runoff being almost negligible. Mine water flows to a sump on the 1,146-ft. level, whence it is pumped to the mill water-supply line by a Goulds triplex pump, with a 4-in. discharge and a capacity of 240 g.p.m. A Union direct-connected centrifugal pump, with a 6-in. discharge and a capacity of 750 g.p.m., is held in reserve on the surface.

On reaching the platform above the bins, each car of ore is pushed by hand into a horizontal-U-shaped tipple, above each of the two ore bins, which automatically dumps the car and returns it to its normal position. A car of waste rock, however, is switched onto a separate line leading to a "horn" dump above the farthest of the three bins, where the contents of the car are

Fig. 3—The open cut. Ore is blasted into raises driven from the level below. Left: Looking northwest; headframe at No. 2 shaft is seen at top center. Right: Looking into the bottom of the southeast end of the open cut.

[1] *Engineering and Mining Journal*, Vol. 124, No. 3, July 16, 1927, p. 99.

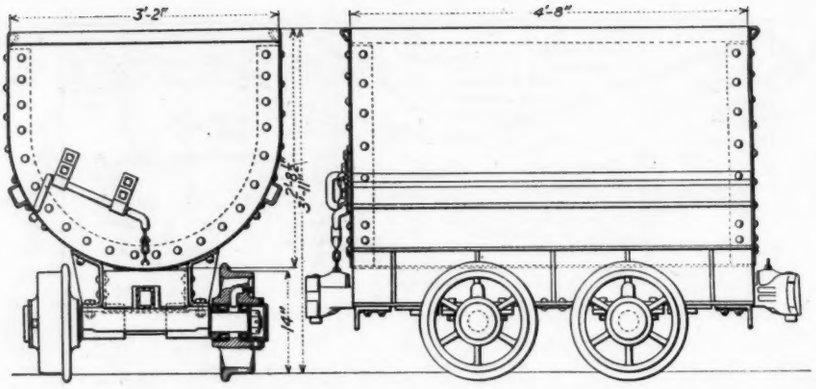


Fig. 4—Roller-bearing-equipped mine car used for transporting ore

emptied through the end door of the car into the waste-rock bin. Inasmuch as the waste-rock cars cannot be dumped in the ore-car tipple, or the ore cars at the waste-rock "horn" dump, contamination of either the ore or the waste rock, one with the other—for a marketable product is prepared from each—is impossible.

Ore and waste rock are drawn from their respective bins through air-operated 60-lb.-rail finger gates into an 80-cu.ft. car, made by the Lorain Steel Company (see Fig. 5). This car, which has a capacity of about four tons of ore or waste rock, is hauled up a 705-ft. 30-in. gage incline tramway, with a 9 per cent grade, to the dumping knuckle in the crusher building by a cable from a single-drum Hardie-Tynes hoist, housed in a separate building with a 50-hp. slipring driving motor. The hoist is operated by remote control, the operator being stationed at the dumping knuckle in the crusher building (see Fig. 2). A rope speed of 800 ft. per minute is employed.

After being automatically dumped into a 30-ton steel hopper below the dumping knuckle, the ore or rock, depending on which is being handled, is fed to a 20-in. Traylor gyratory crusher, with a 4-in. opening, by a 4x16-ft. heavy-duty Traylor apron feeder (see Fig. 6). The crusher product falls onto a 24-in. belt conveyor leading to the top of the screening building, where an Ohio Electric magnet opposite the head pulley removes any tramp iron in the crushed material. A Robins double-deck gyrating screen receives the discharge of the conveyor. The upper 1-in. screen is used solely to protect the lower ½-in. screen from severe pounding and abrasion by scalping off pieces of large size. Both the plus 1-in. and minus 1-in. plus ½-in. material are returned by a 24-in. belt conveyor to a 200-ton steel surge bin in the crusher building. From the bin, the material passes through two Stephens-Adamson 20x20-in. quadrant gates to two Stephens-Adamson 3-ft. by 13-ft. 10½-in. pan feeders that discharge to two Symons cone crushers, with ⅝-in. openings.

The product of the cone crushers falls onto a third 24-in. belt conveyor that also leads to the top of the screening building, discharging onto a ⅜-in. Leahy vibrating screen. Oversize of this screen, a comparatively small quantity, joins the plus 1-in. and minus 1-in. plus ½-in. products of the Robins screen for return to the 200-ton surge bin in the crusher building. Undersize of the Leahy screen, together with the minus ½-in. product of the Robins screen, which consists of a small quantity of wet fine material removed to protect the Symons cone crushers, passes to another 24-in. belt conveyor leading to the top of the mill building. Here, when ore is being treated, the product from the screening building is discharged into a 1,500-ton, suspended, steel mill bin of the bunker type by an automatic traveling tripper distributor. When a crushed-stone product is being made from waste rock, the material on the conveyor leading to the mill building is conveyed across the top of the mill bin and outside the building, where it is stockpiled (see Fig. 2).

From the mill bin, two Schaffer poidometers automatically feed the ore at a uniform rate to the mill circuit.

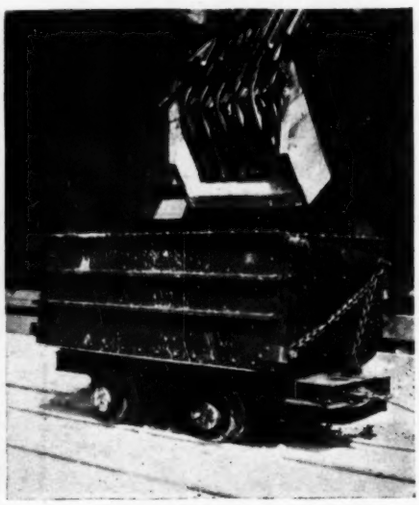


Fig. 5—Air-operated finger gate of one of the chutes leading from the ore and waste-rock bins at No. 4 shaft, and car used on incline tramway

The two poidometers, which also record the weight of the ore fed, discharge onto two 16-in. belt conveyors, and these, in turn, discharge to two 6x12-ft. Traylor rod mills, operating in closed circuit with two 6x25-ft. Dorr duplex classifiers (see Fig. 7). The flow from each of the classifiers comprises the feed to one of two flotation circuits, each of which consists of eight Minerals Separation sub-aëration cells and two Fahrenwald sub-aëration cells. The flow through the various cells in the two circuits is shown in the accompanying flowsheet (see Fig. 6). In one circuit, the feed enters the first M. & S. cell. Finished froth is produced at the second Fahrenwald cell, and finished tailing at the last M. & S. cell. In the other circuit, the feed enters the third M. & S. cell; and finished froth is produced at the first M. & S. cell, and finished tailing at the second Fahrenwald cell.

Flotation concentrate from both circuits passes to a Wilfley pump, the discharge of which is split between two 6x3-ft. Dorrco filters. The dewatered product of the filters, containing 8 to 8½ per cent moisture and 64.5 to 65 per cent metallic zinc, falls onto a 16-in. belt conveyor, about 400 ft. between pulley centers, that discharges directly into railroad cars or into a concentrate storage bin. Tailing from the two flotation circuits flows to one of two 55-ft. Dorr traction thickeners, the overflow of which is returned to the mill water-supply line by a Union centrifugal pump. The thickened product is removed from the thickener by a Dorrco triplex diaphragm pump, whence it passes to a 3-in. Wilfley sand pump that discharges it to the slime pond.

The 20-in. gyratory crusher is driven by a 100-hp. G.E. double squirrel-cage motor, through a Texrope drive. Each of the two Symons cone crushers is operated by a direct-connected 100-hp. G.E. double squirrel-cage motor, through a Falk flexible coupling. All three motors are interchangeable. The crusher feeder is driven by a 15-hp. direct-connected Reliance motor, and each of the other two feeders by a 3-hp. direct-connected Reliance motor. The gyratory and its feeder, as well as the two cone crushers and their respective feeders, are interlocked, so that none of the feeders can be started without starting the complementary crushing unit. This arrangement prevents choking of the crushers. Similar interlocking is employed with many of the other units in the flowsheet. Switches, starters, and push-button controls in the crusher building, and also those in the screening and milling buildings, are grouped together and conveniently situated.

A constant-quantity feed to the flotation section of the mill, achieved with the two poidometers, is considered by the management to be one of the outstanding features of the flowsheet. Tonnage records of the feed to the two rod mills show that, with the same set-

ting of the two poidometers, feed to the two units varies, one from the other, not more than 0.25 per cent.

Each of the rod mills is driven through a flexible coupling by a special direct-connected 150-hp. G.E. squirrel-cage induction motor, and charged with 3-in. high-carbon steel rods, furnished by the Tennessee Coal, Iron & Railroad Company, a subsidiary of the U. S. Steel Corporation, as is the Universal Exploration Company. Iron consumption in the rod mills averages less than 0.6 lb. per ton of ore treated.

Copper sulphate, xanthate, Barrett No. 4 oil, and No. 5 pine oil comprise the reagents employed in the flotation treatment of the ore. The copper sulphate is added at the overflow of the classifiers, and the other reagents are introduced at the flotation cell in each circuit that receives the flow from the classifiers. Reagent consumption per ton of ore treated is as follows: copper sulphate, 0.86 lb.; xanthate, 0.18 lb.; Barrett No. 4 oil, 0.34 lb.; No. 5 pine oil, 0.20 lb. Bucket-type reagent feeders, manufactured by the Denver Equipment Company, are employed.

Normally, 800 tons of ore is mined daily on two eight-hour shifts, with a total underground force of 80 men. The crusher and screening sections of the milling plant operate one nine-hour shift daily, and the rod mill and flotation sections three eight-hour shifts. Four men comprise the mill crew on each shift. One man is stationed in the rod mill section; another in the flotation section, one has charge of the sand pumps and the feeding of reagents, and the fourth is a car loader stationed at the discharge of the belt conveyor that carries the dewatered concentrates.

Chemical and microscopic analyses show a satisfactory extraction—more than 90 per cent—of zinc blende, but not of the oxidized minerals, calamine and smithsonite, that occur largely in the open-cut section of the mine and in zones of open fractures. No method of recovering the oxidized minerals has as yet been developed at the property. As the depth of mining operations increases, the proportion of these minerals in the ore is expected to diminish.

Operating costs have steadily declined since the milling plant was placed in operation in May, 1930, even though a 1929 wage scale has been maintained. In March, 1931, during which month 19,130 tons of ore was mined and milled, costs per ton of ore were as follows: mining, 63.8c.; milling, 47.4c.; general, 20.8c.; total operating cost per ton of ore, $1.32. Plant breakdowns or delays in operation have been reduced to a minimum, the milling plant operating continuously without any such interruption for weeks at a time.

The milling plant, as already indicated, is unusual in many respects. All three buildings and connecting conveyor galleries are of steel and concrete construction throughout and are roomy and well lighted. Inasmuch as each piece of equipment is operated by an individual motor, the structures are entirely free of shafting. A system of illumination, in which Holophane reflectors are employed, provides improved working conditions at night, practically all shadows being removed. The floors consist largely of movable precast reinforced-concrete slabs. Moreover, all the materials used in the construction of the buildings, with the exception of the window lights, were supplied by other subsidiary companies of the U. S. Steel Corporation. The structural steel and the galvanized copper-steel alloy sheets used for the roofing and siding were furnished by the Tennessee Coal, Iron & Railroad Company; cement was supplied by the Universal Atlas Portland Cement Company; piping by the National Tube Company; electric wires and cables were made by the American Steel & Wire Company; and the paint used was the product of the Illinois Steel Company.

Other structures of similar construction on the property include a compressor building and a machine shop and storage building. The compressor building houses (1) a 2,345-cu.ft. Hardie-Tynes cross-compound compressor, equipped with the usual electrical and pressure controls, and driven by a direct-connected 400-hp. G.E. synchronous motor; (2) a 1,050-cu-ft. Ingersoll-Rand compressor, driven by a 150-hp. G.E. motor. This unit is held in reserve. Air at 80-lb. pressure for the operation of eleven rock drills on day shift and eight on night shift is provided by the compressor plant, besides air required for milling and other purposes. The machine shop is completely equipped with new machinery and tools of the latest design.

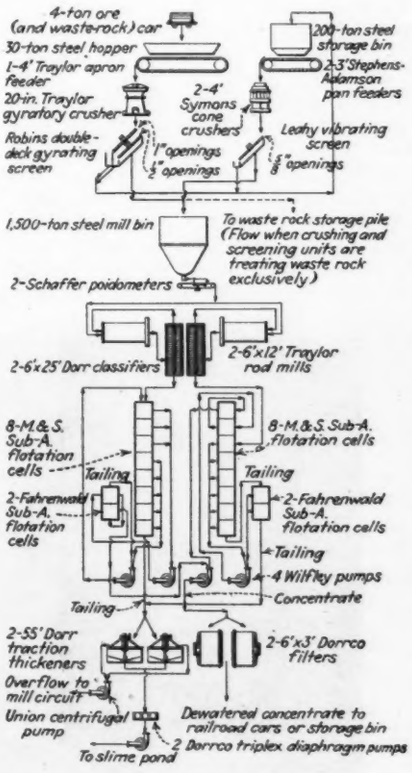


Fig. 6—Flowsheet of milling plant

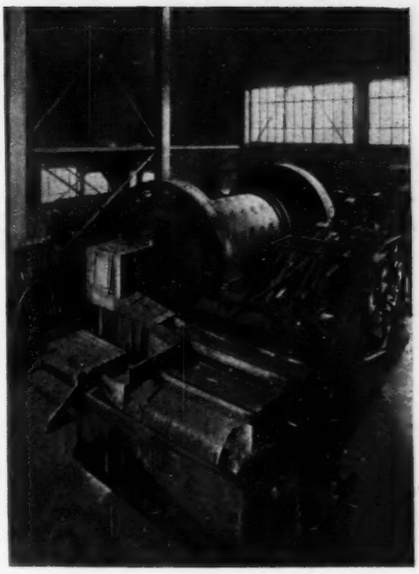


Fig. 7—One of the ball-mill-classifier units. A section of the suspended, bunker-type, steel mill bin is seen in the upper left background

A first-aid building, laboratory, and office building comprise the principal other surface structures. In the first-aid building, an X-ray outfit, besides surgical apparatus and supplies, are at the disposal of the company surgeon. The building also contains two beds and complete first-aid equipment. Chemical and microscopic equipment for analytical investigations are housed in the laboratory building. Office space for the staff is provided in the office building.

In conclusion, the additional statement should be made that the Davis orebody being mined by the company is only one of several ore occurrences that have been identified on the property. Ultimately, the other detached orebodies will be developed and mined simultaneously with the Davis deposit, the ore-treatment plant serving as a central milling unit.

For permission to visit the operations of the Universal Exploration Company, at Jefferson City, Tenn., and for authority to prepare the foregoing account, I am indebted to E. E. Ellis, president of the company. To Floyd Weed, general superintendent at Jefferson City, and to the members of his staff, acknowledgment is made for the information and illustrations presented in the account, as well as for the many courtesies extended to me at the time of my visit.

Supporting Excavations on the Witwatersrand

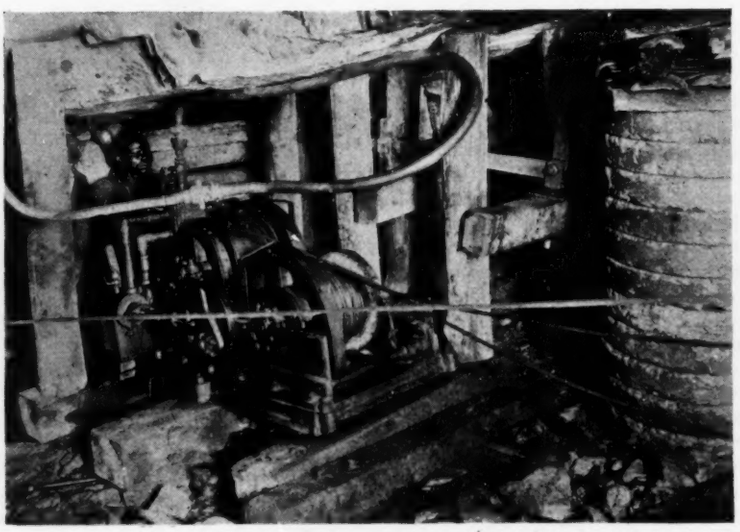
Arthur G. Boyden

IN THE early days of the gold-mining industry on the Witwatersrand, supporting excavations was not the serious problem that it is today. Where dips were steep, from the outcrop downward, the pressure of the slightly overhanging rocks was inconsiderable, though lateral pressure sometimes made itself felt. Down to the 1,000-ft. level, on all dips, pillars were the chief means of support. After this depth was passed, however, the pillars started to crush or punch, depending on whether the pillar or its bounding walls were the harded. Artificial supports in the shape of stulls had to be adopted, which consisted of timber props with lagging laid across them. As the workings became still deeper, even these, in conjunction with pillars, were found insufficient to resist the heavier pressures encountered. So the pigsty was introduced, and, in its loaded form, answered the purpose well. Despite the gradual substitution of better and cheaper forms of support, it is still employed at certain Rand mines. It has the advantage, when dealing with considerable dead weight of hanging wall, of letting it down gently and evenly without fracture. Pigsties, when standardized and properly built, have a fairly long life, if the lagging comprising them is treated with a suitable preservative, such as zinc sulphate; and, if protected with loaded wings, they withstand the effects of blasting even when placed close to the face.

Pigsties, however, have several disadvantages. Unless closely spaced, they allow falls of "hanging" to take place between them, when the roof is naturally friable and the rock loses cohesions. They present only about 144 sq.in. of support to the hanging wall. The reason for filling pigsties is not quite obvious, as by the time the rock filling begins to take pressure, the useful work of, or the damage due to, these supports is already done. After being filled with all sizes of rock, this filling settles to some extent by its own weight, and, if fines are present, by the water it receives when the workings are washed down. Rarely is any attempt made to pack the free space thus caused. Even after the sag of the hanging has reduced stoping width by 25 per cent, the pressure is still chiefly on the timbers at their points of contact. Ungraded broken rock does not consolidate when subjected to weight as sand does. Skeleton pigsties can be protected from the effects of blasting by temporary loaded wings, which, if constructed of hardwood sleepers or partly squared logs, made rigid with destranded wire rope, are eminently satisfactory, though more expensive than when constructed of lagging poles. Maintenance costs apart, it is a puzzle why valuable reef should be consigned to pigsties, or, when waste rock is substituted and the supply is inadequate, why expense should be incurred in taking up the footwall to supply it. The time taken to fill pigsties might be better employed in erecting another urgent support of the skeleton variety. Pigsties, furthermore, are a common cause of mine fires.

Pillars have a lot to answer for. They were roundly condemned, save for exceptional employment, by the Rock-Burst Committees that have been appointed from time to time. They are still used in certain mines on the Far East Rand, where the weight of the hanging wall is taken up to some extent by a soft shale footwall, but even here they must be of considerable size, if auxiliary supports are not put in, and matched by pillars below, when parallel stoping is in force. As regards the deeper levels, a method of support that was first used with success on the Ferreira Deep many years ago has been adopted recently on other mines in the Central Rand. It is not new, but a modification of the "shrinkage" method which is largely in evidence on the steep dips of the Randfontein mines, where the footwall is treacherous.

The method, developed by Paul Selby, is called "reef packing," to avoid confusion, inasmuch as both it and the shrinkage method can claim similar advantages. In the shrinkage method the broken ore is stored in panels, separated by a series of cribbed inspection passes which act as traveling ways. The ore contents of these panels are drawn upon as required from the oldest to the newest, one or two clear panels being left between the working face and the last one to be drawn. With reef packing, no great regularity is observed in the disposition of the panels; they are of varying size, and sometimes have wide intervals between them, but are roughly designed to support about 40 per cent of the surface area of a stope. Chutes are placed in the passages between the packs. Outside walls are first built of slabs of waste rock, piled against stulls. A certain amount of broken ore is "lashed" (shoveled) into the space formed, and thereafter the blast itself automatically fills up the packs, the small space at the top being filled and finished off by natives. In heavy ground, these packs are strengthened by passing lengths of destranded wire rope around the timbers and larger rocks comprising the walls; wire rope ends are turned over about 2 ft.



A column of concrete "pancakes" and a scraper hoist in a mine on the Far East Rand

The advantages of reef packing are significant: It is cheap and efficient; permits rapid advance of the working face, resulting in better control of the hanging, and thus reduces the danger of pressure bursts; enables the ventilation current to be diverted at will; prevents large falls of hanging; and with it little timber is required. Skips can be kept at hauling rock, which is important when the time required for hoisting is increasing. But the method locks up a great deal of ore during initial stages, which in some mines would be a disadvantage. Though reef packs are cheap in first cost, their final cost must include charges for secondary supports, which eventually take the place of the packs, and the interest on the cost of breaking the tonnage packed, for the period it acts as support. Therefore, although taken by itself the reef pack costs 5s. per fathom for a 4-ft. stope, the entire cost would be much more.

Another, and the latest, type of framework support, which is being widely adopted, is that known as the Sloan wire pack, shown in one of the accompanying illustrations. This can be used for either reef or waste packing. It claims to effect a saving of about 40 per cent compared with timber packs. Several mines are now using it, either partly or entirely, as a primary support. Of these the Robinson Deep should be singled out as the first mine to give the pack a thorough trial. Other mines which have followed suit are the Durban Deep, Langlaagte Estate, Village Deep (now absorbed into Robinson Deep), Witwatersrand Deep, and Modder East. Though the large producers of the Far East Rand, such as Government Areas and Van Ryn Estates, are still committed to the use of the concrete pack, they are using the Sloan wire fencing, made of single-strand wire and lighter than the bird-cage mesh, as containers for sand filling, with satisfactory results. The Sloan pack is made of strong baling wire, with rectangular mesh. Packs of any size can be obtained, the most favored being 6 ft. high by 4 ft. in diameter. One native can carry the wire to the spot where it is required. The pack is easily and quickly erected, the rock being piled into the circular or rectangular inclosure formed. In steep working places, four temporary wooden poles are wedged under the lower side to support the structure while filling is taking place. If a strand or two happen to get broken by blasting, the strength of the pack is not lessened. As it takes pressure, the transverse wires are brought closer together, giving the pack additional strength. The larger the pack is made, the cheaper it is per unit of area supported. A pack can be strengthened by building another around it.

With a stope width of 48 in. a pigsty 6 ft. square requires about nineteen 8-ft. pieces of lagging. At a cost of 1s. 6d. per pole, this timber alone would cost £1 8s. 6d., and to this must be added other costs, such as joggling, stacking, dipping, transporting, and erecting. These will vary at different mines but may be taken for comparative purposes as totaling another £1, thus making a total of £2 8s. 6d. for a single pigsty, without the charge for filling. The cost of a concrete support of the "pancake" type for a similar area of "hanging" is as follows:

9 slabs @ 2s. 1d.	18s. 9d.
Erection @ 8d. each	6s. 0d.
Timber cap	3s. 0d.
Total	£1 7s. 9d.

In comparison with the foregoing types of support, the Sloan pack, requiring 9⅓ sq.yd. of wire mesh at 2s. 6d. per sq.yd., has, without a charge for filling but including 4d. for handling, a total cost of £1 3s. 8d. The direct saving compared with the cost of a pigsty is, therefore, £1 4s. 10d., or 51 per cent, and compared with concrete, 14 per cent. Timber required for a pigsty is handled twelve times on the surface, from the time of dumping at the yard, and three times underground before it reaches its final resting place, according to investigations that have been made. A roll of double-stranded, 6-gage wire mesh, 4 ft. wide and 24 ft. long, weighs 72 lb., and, being lightly coiled, is easily handled. A load of 275 rolls weighs twelve tons, and is equivalent, as pack material, to a pile of timber weighing about 225 tons. Other advantages possessed by the wire pack over the pigsty are its complete immunity from fire, longer life, greater ability to stand the effects of blasting, and the larger and more permanent support it offers to the hanging wall. Although concrete is only good for dips up to 30 deg., the Sloan pack, like the pigsty, is efficient on dips up to 50 deg.

Reef packing is applicable to workings 5,000 ft. deep. At greater depths reclaiming becomes more difficult and costly, owing to the quick settlement of the hanging and the impossibility of breaking sufficient waste for secondary supports, after the reef reserves have been reclaimed. Moreover, support of the hanging at great depths tends to be expensive, because an intact hanging must be provided at each stope face, as well as a good general support in worked-out areas, to reduce the concentrated and accumulating pressure on the newer and lower workings. Under such conditions, in stoping widths of 48 in., reclamation of ore left behind becomes difficult and expensive, if not accomplished within 60 ft. of the face. To remove these handicaps, and to meet the growing danger of pressure-bursting areas, a special system of waste packing was recently adopted on the City Deep. This waste packing is carried ont in conjunction with a modified or inverted form of "resuing" and has the advantage of filling excavations to nearly 100 per cent of their capacity. In this respect it resembles sand filling as the ideal support. The method of stoping is first to overcut the payable reef channel, and then to come back and mine it off the footwall. The waste or unpayable bands of reef are stoped out to a distance of 8 or 10 ft. This spoil is packed in the excavation behind with a minimum amount of effort, owing to the assistance received from blasting and the dip of the footwall. If the reef is very narrow, say 6 in., the waste must be stoped at least 36 in. to provide room for movement. Any excess of waste over that required for the fill is lashed out and trammed, either as reef or waste, or it can be used to make up a deficiency of waste in the stopes below.

If the excess waste is hoisted as reef, the resultant milling width of the stope, with an over-all width of 42 in., could not be much more than 17 in., if the excavation behind is filled with waste. Before resuing is started, a row of 7 in. sticks, 7 ft. apart, is erected along the face and about 2 ft. from it. To make the method successful, these sticks must

A Sloan wire pack taking weight in a Witwatersrand gold mine

be in a straight line. A barricade of lagging is built up on the inside of these sticks, and a line of chutes driven in the footwall along the face, between it and the barricade, to facilitate lashing when mining of the reef takes place. As soon as the barricade is completed, waste stoping is started and the face kept parallel to the line of sticks supporting the barricade. During the advance of the waste stoping face, the hanging is supported by 7-in. sticks, 18 in. or more long. When the waste lashed in behind the barricade actually reaches it, waste stoping is stopped, and mining of the reef off the footwall is started. This is done by pop-holing and by barring with machines, weighing 50 to 60 lb., and designed originally for breaking concrete.

The footwall is carried to a distance of one or two feet from the waste face, a ledge thus being provided for starting the new overcut. The short sticks supporting the hanging during the waste cut drop out as removal of the reef proceeds. They are replaced by longer poles, most of which are withdrawn, as the waste fill reaches them, and used again. When mining of the reef is completed and the fines have been lashed down, the barricade and ground chutes are transferred to a new line, and waste stoping is started again. The average advance per face per month is about 10 ft., the area stoped per month per 180 ft. of face being about 50 fathoms. The time allotted for waste stoping is 12 to 16 days, and for removal of the reef 6 to 8 days. During this last period, when hand labor and chutes are used, about 6 to 10 extra lashing boys are brought into the stope. If mechanical scrapers are employed, only four boys are required.

The resuing-waste-packing method has not only proved satisfactory in supporting the hanging under trying conditions but also, at the City Deep, has not increased the cost per ton milled; as a result this mine is now working almost entirely on the resuing system. For stoping at depth below the 5,000-ft. level, the method will probably be found to be the best and cheapest so far developed. First costs are final, as once the stoped area is filled, no subsequent reclamation can take place; and, for the same reason, any fall of hanging, however severe, is rendered innocuous. This method of withstanding and anticipating great and unequal rock pressures has been described at length here because of its probable importance to other mining fields where similar conditions prevail or may soon be expected. One improvement might be suggested, and that is to pack the waste closer to the face against the barrier, instead of allowing it to assume the natural angle of repose.

The nearest approach to an ideal support is, undoubtedly, sand filling, inasmuch as it is almost a replacement of the solid rock. At some mines the practice is to stope a reef and support with reef packs, then reclaim the packs and any payable reef not previously mined, after which the area is sand filled. The sand may be used as the footwall for the reef above, a raise being put through the sand, from which mining of the upper bands of reef proceeds. The first requisite in using sand underground is to destroy its cyanide content by adding some cyanicide, such as potassium permanganate. The sand is first mixed with water in a suitable proportion to insure flow, the mixture then being pumped to cone classifiers, immediately above the borehole. On discharging from the borehole, the pulp, which should be made of good clean sand, is conveyed by launder to the stope to be filled. It flows to timber barricades, supported by stone walls and lined with either a thick layer of ash or cocoanut matting for drainage purposes. Side barriers are also erected to confine the pulp to the particular section it is desired to sand fill. Specially constructed launders, having a perforated bottom and lined with ash, are sometimes placed on the footwall to assist in removing the water content of the sand; but these are being dispensed with. A 30 per cent mixture requires a launder grade of 30 per cent or 17 deg. The lowest inclination at which pulp will run is about 6 deg., which, unless the launders can be sufficiently elevated, rules out the method for very flat dips.

At the Witwatersrand Deep the cost of sand filling is about 7.5d. per ton. The Van Ryn Deep recently put down a borehole to the 2,000-ft. level for sand filling purposes. The Modder Deep Levels is sending all its sand residues underground for the purpose of filling up worked-out areas and partly as primary support for the development of upper reef leaders, at an inclusive cost of 6.6d. per ton of sand. At the Simmer and Jack mine sand filling is used not only for the recovery of valuable pillars but also in stoping, the work proceeding right up to the breast and only sufficient sand being scooped out against the face to allow stoping to proceed. This expedient has the triple advantage of supporting the hanging wall at a low cost, reducing the total amount of air required for ventilation purposes, and avoiding the scattering of valuable fines in blasting. Though this mine has two boreholes, advantage is taken of the old outcrop workings to convey much of the sand underground. The inclusive cost of sand filling at the Simmer and Jack is 7.5d. per ton of sand. The cost of transporting treated sand to the dump is about 6d. per ton; but the difference of 1d. in favor of dumping is more than offset by the advantages accruing from the solid, permanent support of old workings and new stopes by sand filling. The otherwise inevitable charge for dumping is actually applied to a remunerative purpose. Though first charges of putting down boreholes are heavy, at least two being required for any large mine and costing about £5,000 per 6,000 ft. of drilling, maintenance costs are light. Sand filling would have the effect of at least making a large rock-burst innocuous, and for operations at extreme depth it presses for notice as a reliable primary support.

Concrete for support is largely and exclusively used on the mines of the Far East Rand. This method is good for dips up to 30 deg. By its use, a much smaller percentage of area is required for support, and ventilation is improved in working stopes. Concrete pillars become harder and tougher with age, whereas pigsties disintegrate. The pillars prevent the hanging from becoming "live" too soon, take considerable weight, and withstand blasting well, especially when equipped with timber "corsets." They maintain the original width of the stope and do not lock up valuable fines, as pigsties do. Their high compressive strength prevents disruption of the hanging, the rock not being strained to the degree that it is with pigsties. Local falls of rock in concrete-supported stopes rarely occur. With jackhammer stoping, concrete packs can be built within a foot of the face, without suffering damage. The first cost is the entire cost, whereas pigsties may have to be reconditioned again and again. Finally, the resisting power of concrete can be definitely ascertained; the ultimate strength of pigsties is an unknown quantity.

The concrete "pancake" was evolved after much experimenting. It is a plain, flat disk, 4 in. or more thick, about 30 inches wide, with a 4 in. hole in the center to facilitate transport, and weighing up to 250 lb. The disks are made in molds, the mixture being in the proportion of 7 parts of 1½-in. quartzite rock, 3 parts of washed sand, and 1 part cement. They are reinforced with strands of wire rope, and, after being pickled, are loaded into a special skip-container, which is placed on a platform wagon, sent to the shafthead, and lowered into the mine. The slabs can quickly be put into position, once a foundation of concrete has been prepared on the footwall to receive them. They are built up to within one or two feet of the hanging wall, the remaining space then being filled with small chocks or lagging which are tightly wedged against the hanging.

On flat dips, pancakes offer enough frictional resistance to prevent shifting; on steeper inclines, a thin layer of cement or dry sand is interposed. Owing to their adoption, in conjunction with 10-ft. pillar support on the New State Areas, no interruption of work has occurred during three years in any stope from falls or movement of the hanging, save a week's delay on 100 ft. of face, and, during that period, 140,000 fathoms have been stoped. Though concrete supports of the pancake type are much in use, where applicable, they are not nearly as strong as sand-filled, reinforced concrete or steel tubular members. Tests made with such reinforced concrete rings have led to their adoption on the Far East Rand.

From a strictly economic viewpoint,

waste packing is the cheapest form of support, depending to some extent on whether waste rock is available without being specially broken for the purpose. The relative costs of the different types of support are presented in Table I. Apart from costs, the choice of any of the various types of support is governed by dip, depth, and rock conditions.

Table I—Costs of Various Types of Support

	Stope Width, Ins.	Per Fathom
Reef packing	48	(a) 5s. 0d.
Waste packing, bird-cage method	48	3s. 9d.
Waste packing, resuing method	..	24s. 0d.
Sand filling	52	(b) 4s. 4.75d.
Concrete pillars	60	(b) 6s. 6d.

(a) exclusive of secondary support charges and interest on ore tied up. (b) inclusive.

As indicated in Table I the cost of support by the resuing method is high, being more than six times greater than that offered by the bird-cage method of waste packing. Concerning this, all that one can say at present is that the resuing method represents an expedient to meet abnormal rock conditions below the 5,000-ft. level; and, inasmuch as it requires a top and bottom row of strong, closely set pigsties, it is really a compound of two distinct methods of primary support. The separated cost of breaking ground by the resuing method is about 40s. per fathom.

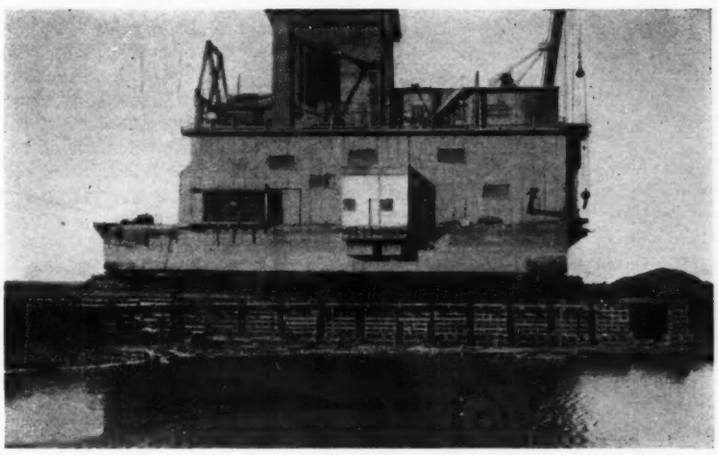
The relative costs of concrete an timber packs in detail, based on a stoping width of 60 in., follow:

Table II—Detail of Pack Costs

	Concrete Pack	Timber Pack
Cement	13s. 6d.	.....
Sand	4s. 0d.	.....
Timber	4s. 6d.	23s. 0d.
Sundries	2s. 6d.	1s. 0d.
European wages	3s. 6d.	3s. 6d.
Native wages	4s. 6d.	6s. 0d.
	32s. 6d.	33s. 6d.

In conclusion I wish to acknowledge my indebtedness for data presented here that have been abstracted from *The Journal of the Chemical, Metallurgical and Mining Society of South Africa.*

Moving a Gold Dredge Overland



Dredge cribbed up in original pond for transport to new site

IN MOVING a gold dredge to a new area, the usual procedure is either to dredge a channel to the new site or to dismantle the dredge and re-erect it there. A third plan was adopted by the Hammon Consolidated Gold Fields Company, at Nome, Alaska. This company, a subsidiary of the U. S. Mining, Smelting & Refining Company, made a contract in June, 1930, with Curtis Brothers, Inc., of Seattle, to move its No. 2, 9-cu.ft. gold dredge from Little Creek to Center Creek, a distance of 8,000 ft.

Delivery of the dredge to its new site was to be effected not later than May 1, 1931. Moving operations started Aug. 24, 1930, and the dredge was placed in its new pond, Jan. 8, 1931. Climatic and surface conditions were important factors. During the thawing period numerous holes were dug for "deadmen" anchorages. The dredge was partly dismantled, the bucket chain, ladder, spuds, and stacker being removed. The remaining weight was estimated to be 2,000 tons, which included the temporary timber carriage under the hull.

Removal of the hull from the pond was accomplished during favorable weather, but its transport had to be delayed until the tundra was frozen sufficiently by winter conditions to provide adequate support. The route selected included an area 20 ft. higher than the original pond, and the dredge therefore had to be raised this 20 ft., as well as lowered 60 ft. This was accomplished by means of cribbing, a level runway being maintained, however, at all times. Two turns, one of 5 deg. and the other 17 deg., were involved and at these points the rail-tie runway was widened to accommodate the swing of the hull. Average daily progress was 240 ft. the maximum movement being 380 ft., which distance was covered on each of two different days. Operations were continued sixteen hours per day, even in the severest weather. A total of 300,000 ft. of lumber was used, and 30 men were employed.

In removing the dredge from the old pond, the water was raised as high as possible, and a shallow pond dug ahead of the old pond. The dredge was then partly dismantled, floated back into the old pond, and the water lowered. A substantial foundation was constructed in the shallow area, and then weighted down. The pond was raised again, and the dredge floated onto the foundations. After lowering the water again, the dredge was raised by jacks and cribbing to a height of 12 ft. above the bottom of the shallow pond. Immediately beneath the hull, 24 timbers, 20x24-in. x56-ft., were placed at 5-ft. centers transverse to the longitudinal axis. Additional timbers were placed at the areas of greatest weight. Transverse timbers rested on 26x26-in. longitudinal timbers, 26 ft. center to center. Three 44-ft. timbers, placed end to end, extended from the bow to the stern, and gave the necessary overhang at each end. Thirty fabricated steel shoes, fifteen on each side, were placed beneath the longitudinal timbers. Each was 10 in. high, 16 in. wide, and 7 ft. in length, and constructed of three I-beams bolted together with spreaders between. The shoes were rounded at the front ends. Rollers made of 3-in. shafting were used. Four parallel 60-lb. railroad rails on each side carried the load, and rested on 12x16-in. timbers, parallel to the rails. Beneath were railroad ties, placed closely together. The motive power for moving the dredge was the ladder hoist winch and its motor. Two 60-hp. Caterpillar tractors were used for pulling blocking and cables and for miscellaneous transportation.

To protect the workmen from the weather, a framework, covered with canvas, was erected 75 ft. ahead of the dredge, and another behind it. Under this protection the trackage behind the dredge could be carried forward without exposing to the weather the men engaged in the work.

Caving Methods

Morris J. Elsing

CAVING methods of mining were first introduced to Western mining districts in an important way at the Ohio Copper Company's property in Bingham Canyon, Utah, in 1906. The success of the operation was epochal in character. The Ohio company and the Utah Copper Company were pioneers in the field of mining low-grade copper ores. Although the financial results obtained by the first-mentioned company were not nearly so satisfactory as were those of the latter company, the very successful results of its methods had a far-reaching effect on mine development in Western United States.

Utah Copper had proved the practicability of mining large tonnages of low-grade copper ore by steam-shovel methods, but it remained for Ohio Copper to demonstrate that sufficiently low mining costs could be obtained by applying caving methods of mining to make profitable low-grade ore which occurred underground. The success of this operation was the beginning of a new era in the exploration and development of low-grade orebodies which could not be mined by steam shovels from open pits. The stimulus provided by both of these successes resulted in an intensive campaign of churn drilling and underground exploration. Many great orebodies were found and the existence of the so-called porphyry mines was established.

FOLLOWING Ohio Copper, the first of the underground porphyry mines to reach the stage of production was the Ray Consolidated Copper Company, whose mill started producing in 1911. This operation was followed in close succession by the Inspiration Consolidated and a little later by the Miami Copper Company. In 1916, the Nevada Consolidated developed a caving method for mining its Ruth orebody. In 1911, the Morenci Branch of the Phelps Dodge Corporation produced about 14,000 tons of ore by a so-called block-caving method, but caving at this mine did not become important until 1922. One variation of the method was known as the Morenci slide method, and a modification of this practice was later used at the Old Dominion mine at Globe, Ariz.

The first real caving methods were used at Cananea, Sonora, Mexico, in 1922. In 1925, the Copper Queen Branch of the Phelps Dodge Corporation adopted the caving method in the mining of some of its disseminated ore in the vicinity of Sacramento Hill. The Andes Copper Company and the Consolidated Coppermines are the latest to employ caving methods, the former in 1926 and the latter in 1928.

It is now almost twenty years since the three big Arizona porphyry mines, Ray, Inspiration, and Miami, started their caving operations. A glance at the records of production per man-shift underground is illuminating. The data in Table I have been taken from the U. S. Bureau of Mines Information Circular No. 6350 and also from company annual reports.

Table I—Tons per Man-shift Underground

Mine	Year	Tons
Ray	1928	12.1
Inspiration	1928	13.1
Miami	4-yr. aver.	27.0
Morenci	1928	11.8

The annual reports of Inspiration Consolidated show that in 1929 production from the sulphide orebody was 9.22 tons per man-shift and from the leaching orebody 13.78 tons. In 1930, total production was 15.06 tons per man-shift. In the last ten years the greatest production was 17.5 tons, in 1924, and the lowest was 11.74 tons, in 1926.

According to an article by Clarence G. Bamberger in *Engineering and Mining Journal*, April 6, 1912, production of the Ohio Copper Company in October, 1911, was 17 tons per man-shift. That after twenty years of caving, with the great improvements made in methods, only the Miami Copper Company and for one year the Inspiration show a larger tonnage per man-shift is surprising. This fact is still more surprising when one realizes that production of the Ohio Copper Company was only 1,800 tons per day, compared to five or ten times this amount from the other mines when operating at their normal productions.

Also of interest is the fact that at Inspiration a 50 per cent greater production per man-shift was made from the leaching orebody than from the sulphide orebody and that the neighboring Miami mine has a production three times as great per man-shift as the production from the sulphide orebody at the Inspiration.

These records show that at one mine the output may be three times as great as at another and that in different parts of the same mine the production per man-shift may be 50 per cent greater. Many reasons can be given to account for such variations, but the factor involved in ground conditions is the most important variable which determines the output per man-shift.

These considerations lead to the subject of the mechanics of caving, which has been ably discussed by E. D. Gardner in the Information Circular already mentioned. Wide differences of opinion have been recorded, and little is known as to what actually happens in the process of caving. With a homogeneous rock mass the laws of mechanics should operate and processes and results should be consistently the same. The great difficulty is that caving is never done where there is a homogeneous mass. Instead, a multitude of unknown variables exist, and all have their effect, and until much more is known results cannot be definitely predicted. In other words, in the simplest case the laws of mechanics must apply, and such laws still do apply in the more complicated cases, but the effect of shearing, fracturing, sheeting, and faulting of the ore itself, added to the physical and chemical characteristics of the ore, so complicate the problem that specific deductions should be made with caution.

From my own personal experience and observations, I think one general deduction can be drawn. To me the most important necessity for efficient caving appears to be that the physical characteristics of the ore be favorable. The ore should be sufficiently strong to support great weight and yet sufficiently friable and brittle to cave readily in small pieces when undercutting is done.

To me the Ohio Copper Company's orebody appears to be an example in which the physical characteristics were ideal, and the Capote 15 orebody at Cananea is an example diametrically opposite. The Ohio orebody was about 400 ft. wide, 450 ft. long and 1,300 ft. deep on an incline of 50 deg. It was a "mass of broken shattered quartzite containing disseminated chalcopyrite." Both footwall and hanging wall were quartzite. Capote 15 orebody was an almost vertical breccia pipe about 130 ft. wide, 350 ft. long, and several hundred feet deep. Practically the whole of the pipe was composed of exceedingly altered material, but it contained small and large unaltered boulders of quartzite and porphyry fragments. The main constituent of the altered mass was sericite, with some talc and kaolin. If kept small, subdrifts could be driven in the ore without timber, but when enlarged to normal size they would stand open only a short time. All level drifts in the ore were timbered, but until caving started this timber took no weight. The ore minerals were chalcopyrite and bornite, with occasional masses and stringers of pyrite. This character of ground prevailed from the 1,100 to the 1,500 level.

IN NO SENSE of the word could the ground be classed as heavy; neither was it uniform in the amount of alteration which had taken place. In drifting, it required machine drilling, but except

when drilling in the harder unaltered fragments it could be called easy-drilling ground. The level drifts and crosscuts were seldom advanced more than 10 or 15 ft. ahead of the timbering. The whole pipe was surrounded by unaltered granite which, although not hard, stood without timber in all of the main drifts.

Levels were spaced 100 ft. apart. A haulage drift was driven on each side of the orebody parallel to it and crosscuts through the orebody were run at 40-ft. intervals connecting one haulage drift with the other. These crosscuts were timbered with 10 by 10-in. timbers. Sets were placed 20 in. apart and separated from one another by 10-in. blocks. At intervals of 15 or 20 ft. single-compartment raises were driven to an intermediate level 25 ft. above the main level. On this intermediate level, checkerboard drifts were driven at right angles about 20 ft. apart, and, at intersections, connection was made with the tops of the one-compartment raises from the level below. These drifts were kept small, usually less than 4 by 6 ft. until caving operations started.

Caving was started by enlarging these drifts near the chutes and if necessary by drilling and blasting the remaining portion of the ground between them and the next chute and crosscut. The simple process of enlarging the drifts at the top of these raises was usually sufficient to start caving. On the level the ore was drawn from the chutes into 1-ton cars, which were hand-trammed to the shaft ore pockets.

As soon as caving was under way over any considerable area, the 16-ft. pillar of ore above the top of the crosscut level drifts crushed and the timbers took great weight. It was this anticipated weight which made necessary the placing of sets at 20-in. centers. Drawing of ore was continued just as long as these drift sets permitted the passage of the ore cars. When this was no longer possible, drawing was discontinued and the drift was retimbered. It was usually the custom to have every alternate drift under repair. Generally, as soon as the drift had been entirely retimbered, drawing would be started and the drifts 40 ft. on either side of it would be retimbered. To insure speed in this repair work, four or five timber crews were required to get the drift ready for the next drawing.

Total costs per ton varied from $1.50 to $2, which included a prospect and development charge of about 30c. per ton. One of the largest cost items was the repair work necessary to keep open the extraction drifts above described. On the average about 5 tons of ore was produced per man-shift.

In many ways the operations at the two properties mentioned are comparable. The daily tonnage extracted was not greatly different. The difference in size of the ore deposits does not account for the great difference in daily output per man, but the difference in the physical characteristics of the ore does do so readily.

WHAT processes actually take place in workings in solid ground below caving operations is somewhat of a conjecture. In the first place, caving sets in motion large masses above the caved section. These masses, either broken or in large blocks, must be supported by the solid ground in which the haulage or grizzly levels are located. Often this ground is not sufficiently strong to support the weight imposed, with the result that it crushes. This process is analogous to the crushing of any material which is subjected to pressure. The point of failure is reached and the material breaks down. Either one of two things may happen, but usually the result is a combination of the two extremes. If the material crushed tends to be plastic, the most extreme case of "taking weight" occurs. The weight is transmitted in a more or less hydrostatic manner. This may be expressed in the form of pressure from the top of the drift, or the side or even the bottom. In so-called swelling ground, the "weight" may be caused by oxidation of the material exposed, and in this particular event the resulting weight can be explained by chemical processes. However, when a drift has been opened for months and no such weight results, and this weight develops only after there has been some disturbance above it by either top-slicing, caving, or even square-set stoping, one may reasonably conclude that the nature of this "weight" is similar to hydrostatic pressure. I see no other explanation of the fact that the bottom of a drift "comes up" with just as much force as the top comes down. My experience is that such an occurrence takes place only in ground which is sericitic or talcy, or that contains a considerable amount of the usual rock-alteration products. Such ground tends to be plastic. It often forces its way between timber and forces timber down into it, or else the bottom comes up to meet the roof. The whole rock mass is more or less mobile, and I have long held the opinion that ground of such a character is the most difficult to mine, by caving, top-slicing, or any other method.

GROUND may crush below the caved area, but if it does not have the characteristic of "plasticity," the weight will not become nearly so great. It exhibits none of the tendency to flow which is so forcibly exhibited in ground of a plastic nature. Much of the weight is supported by the crushed material itself and does not resolve itself into lateral thrust, as is the result in the plastic ground.

In deciding upon caving and determining the detailed methods, the plasticity of the ground should be given due consideration. For example, a decision should be made as to whether or not the crushed ore is likely to be plastic. Hard siliceous quartzite will seldom tend to have this characteristic unless it has been subjected to extensive metamorphism with the resulting sericitization. As a matter of fact, I believe that the degree of sericitization is one of the most important considerations in attempting to predict the results of caving. That sericite acts in the nature of a lubricant is entirely possible. Certainly no more difficult problem arises in timber blocking than that of blocking against sericitic boulders, and one may reasonably expect that such material would make the least stable support for broken ground above it. Of course, many conditions have their effect on the stability of the ore or rock in the drawing-off and haulage levels. Sheeting, shearing, fracturing, and faulting all have their effects, but when sericitization accompanied them, the ground becomes just so much more difficult to hold.

What has been said regarding plasticity and sericitization is more or less independent of what particular theory of the mechanics of caving is accepted. Possibly, there may be cantilever effects resulting in a fulcrum, where the taking of weight may be more evident. However, if zones of plasticity exist, the evidence of weight may exhibit itself at some distance from the actual fulcrum. The distance at which this phenomenon exhibits itself is sometimes surprising. In some mining operations workings 100 ft. below the undercutting levels become seriously heavy. Distances of over 200 ft. are not uncommon. The same result occurs to a lesser extent in top-slicing plastic ores. However, I have seldom seen this transmittal of weight for more than 60 or 70 ft. below the floor of a top-slice that is being worked, and in most instances it is confined to the first 30 ft. below the working floor.

This characteristic of plasticity is detrimental in other ways than in transmittal of weight. Plastic ore is seldom free-flowing. It often tends to pack, and, when it finally runs, tends to pipe and thus prevent the uniform drawing which is so desirable. Draw holes must be placed closer and greater care must be observed in the drawing of the mined material.

Summarizing what has been said relative to the variable output per man-shift, I believe that soft ore and weak ground on the drawing-off and haulage levels account for low output per man-shift. This condition explains why one section of the Inspiration has a 50 per cent greater output than another. It also accounts for the fact that in past years the Inspiration output has been almost 100 per cent greater than that from the present sulphide orebody. Most of the other variations can be similarly explained. Caving methods

can be modified to increase their efficiency, but unfavorable ground conditions are unsurmountable difficulties in the way of attaining a great output per man-shift.

USUALLY, the larger the scale of operations, the lower are the costs, but the results obtained by the Ohio Copper Company indicate that great tonnages are not an absolute necessity for low cost. According to C. G. Bamberger, in October, 1911, the total cost of ore delivered to the bins was 28.06c. This cost includes development and equipment charges and, with due allowance for the present higher commodity prices, compares favorably with the lowest cost today. Furthermore, this cost is remarkable when one considers the fact that the tonnage was only 1,800 per day. Evidently, favorable conditions can offset the advantages that result by reason of the larger scale of production obtained at other mines.

The opinion is generally held that not only must the scale of caving operations be large but that the production must be confined to one or two orebodies. Total tonnage may be large, but many authorities hold that if such a tonnage occurs in comparatively small isolated bodies, high costs necessarily result. In general, this opinion is correct, but under certain conditions small orebodies can be successfully caved. These include, first, favorable ground, and, second, a large vertical column of ore. The largest of the items which make up the cost of caving is the cost of development work and undercutting. Total cost of this work is practically the same for an ore column 100 or 300 ft. high, and, when distributed over the greater tonnage represented by the 300-ft. column, the cost per ton becomes much lower. When the height of the ore column is 200 ft. and the ground conditions are favorable, a low cost can be obtained from an orebody containing as little as 1,000,000 tons, provided there are several such orebodies and a total production of several thousand tons per day is maintained. Unquestionably, with the same tonnage the total cost of production from several isolated orebodies will be greater than when derived from a single large orebody. This increase will be partly due to the cost of the increased length of the haulage drift required to connect the isolated orebodies with the main hoisting shaft. When the cost of such a drift is distributed over 1,000,000 tons, the increased cost per ton has no appreciable effect. Isolation slightly increases some of the overhead costs, such as ventilation, drainage and supervision, and the like, but when these increases are added to a stoping cost which is closely similar, the final result will not be materially higher.

As to the vertical height of the ore column, we find in Bureau of Mines Information Circular 6350 certain information relative to the height of the block to be caved. These data are presented in Table II.

Table II—Vertical Height of Ore Column

	—Height of Block in Feet—		
	Min.	Max.	Average
Andes	...	330	...
Copper Queen	60	250	...
Inspiration	125	250	...
Miami	...	320	...
Morenci	150	270	164
Old Dominion	...	100	...
Ray	100	300	...
Ruth	40	200	135

In view of the great variations in the figures in Table II, representing the minimum height of the ore column, a word of explanation is needed. As understood in most cases, these refer to the minimum thickness of the blocks being worked and not to the minimum thickness of blocks which can be profitably worked. For example, caving can be applied successfully to ore at Morenci where the thickness of the ore is much less than 150 ft. Obviously, the cost of mining per ton varies according to the height of the column of ore being caved. This is graphically illustrated in F. W. Maclennan's treatise on "Miami Copper Company's Method of Mining Low-grade Orebody," which is one of the most outstanding single contributions on caving, if not on any mining method, that has ever been written.

Mr. Maclennan shows by a curve the cost of mining per ton for varying thickness of ore. Where ore is only 25 ft. thick, the cost per ton is $1.56; when 50 ft. thick the cost is reduced to 96c. per ton; when 75 ft. thick the cost is 73c., and when 100 ft. thick the cost is reduced to 62c. per ton. Obviously, these figures are based on the Miami method of caving, and for each thickness of ore practically the same stope preparation and haulage development are necessary. At a cost of $1.56, other methods of stoping become competitors, and undercut block-caving would be out of the question. If the other characteristics of the ore were suitable to caving, a competitive method would be the sublevel caving method with the use of scrapers. This method would require much less development work, and would probably give a total cost of not over $1 per ton. Such costs for sublevel caving are not uncommon in the iron country of Michigan and Minnesota.

Summarizing the question of the minimum thickness of ore which can be worked by caving methods, I believe that, under normal conditions, ore which is from 80 to 100 ft. thick should be profitable at any of the mines mentioned in the accompanying Table II. With a slight increase in grade, the thickness of the ore can be decreased to from 40 to 60 ft. With a thickness of 25 ft., sublevel caving could be substituted for undercut block caving. The deductions above outlined apply only to the conditions obtaining in the low-grade porphyry mines. Any substantial increase in grade will make higher-cost methods of mining competitive, especially when mining the thinner orebodies.

With respect to recovery and dilution, general deductions from the results obtained in caving operations can be made as to reduction of the grade of ore, the tonnage, and the amount of metal that will be obtained. These are set down as follows:

1. The grade of the ore obtained will be from 75 to 90 per cent of that estimated in the block to be caved.

2. The tonnage obtained will be from 90 to 115 per cent.

3. The total metal content recovered will be from 85 to 100 per cent of the metal in the block.

Of these figures the most important is the grade of ore which will be obtained from caving operations. The first ore drawn comes clean; that is, with no dilution from capping. At Miami nearly 80 per cent of the ore shows no dilution. This figure is exceptionally high and indicates ideal ground conditions combined with good practice.

After dilution begins to be evident, the ore generally becomes lower and lower in grade. The point at which drawing should be stopped is really an economic problem. However, operators are not agreed as to how far drawing should be continued, inasmuch as other factors, such as mill capacity and general policies, play an important part.

ONE phase of caving methods which is intensely interesting and has great possibilities is that of leaching ore in place underground. I think this question has been insufficiently emphasized both in the technical press or by actual experimental test. The fact that substantial amounts of copper will eventually be recovered by leaching the worked-out caved areas at most porphyry mines is generally conceded. At the Ohio Copper Company's mine this method has been very successful and much copper has been economically recovered. At Cananea, a great deal of leaching has been done in several of the old mines which were originally worked by top-slicing or square-setting. Good recoveries were made from some old shrinkage stopes in which the ore was of too low grade to show substantial profits by milling. Dump leaching has also been successfully done in many camps, but so far as I know, no extensive leaching experiments on broken ore in place have been attempted at any of the large porphyry mines.

My own experience with leaching leads me to believe that a combination of caving with milling and leaching offers possibilities. Such an operation might be carried on as a normal caving operation, but instead of continuing the drawing of ore to the point of no profit, drawing would be stopped as soon as dilution appeared. The remaining mixed ore and waste might then be leached at a greater profit than if it were milled.

Two important points are the per-

centage of recovery and the time required for such recovery. These would depend upon the chemical and physical characteristics of the ore. Assuming that the chemical characteristics were favorable, the main physical characteristic which might interfere would be a tendency of the ore to form solution channels which might prevent access of the solutions to all parts of the broken mass. Whenever such a condition arises, channels could easily be broken up by the drawing of additional ore, and in this way the whole mass could be thoroughly leached. In this respect underground leaching could be more effectively done than surface heap-leaching where channels cannot be broken up.

The subject is worthy of considerable study and some large-scale experiments. If such experiments were successful, the fact might easily be proved that a minimum amount of ore would have to be mined and milled in order to cave the ore column, and that the remainder could be leached. One may assume that to leach a given block of ground successfully it must be thoroughly broken and that to do this would require that 35 to 40 per cent of it be removed to make room for the "overbreak," as in shrinkage stoping. This "overbreak" would be removed by ordinary caving methods and milled, and the remaining ore would be leached. The results of leaching at Cananea indicate that such a combination of caving and leaching is more than a possibility.

■ ■ ■

Calculating Average Particle Size From Screen Analysis

F. C. Bond

IN CALCULATING the average grain diameter in a screen analysis the chief difficulty lies in the disposal of the undersize from the finest screen used, ordinarily 200 mesh. Applying Stadler's ordinal numbers to the Tyler standard screen scale, the value of the ordinal number of the 200-mesh screen, increased by 2, is generally assigned to the material below 200 mesh. If the 200-mesh screen is No. 13, the undersize will be No. 15.

That the size distribution of the minus-200-mesh material varies with different ores, with finer grinding, and with different grinding conditions is obvious. Such variation is relatively unimportant where the amount of minus-200-mesh material is small; where it is large, appreciable errors may be introduced in comparing the calculated average diameters of different samples. Certain recent work in the Allis-Chalmers mining laboratory indicates that the average minus-200-mesh material is better represented by adding 1.7 to the ordinal number of the 200 mesh screen; different samples, however, may vary greatly.

Although the average grain sizes of various materials passing through a certain screen may differ widely, the relative size distribution of the half containing the larger grains and the half containing the smaller grains is nearly constant. This shows up best on graphic illustrations of screen analyses. No valid reason is apparent that this relation should not exist below 200 mesh as well. The use of a median value rather than the average value therefore suggests itself.

If all grains in a sample were ranged evenly from the largest size to the smallest, and the material divided into two equal portions by weight, the average diameter of the hypothetical grain separating the two halves would be the median diameter of the sample. The median diameter ordinarily differs slightly from the average diameter, as the size distribution of one of the two halves of the sample does not correspond exactly to that of the other. This difference, however, becomes less important in view of the fact that the median value is used chiefly for comparison of related types of materials with similar size distribution.

The accompanying table gives the sieve number (n), the mesh, the screen opening in microns, and the average diameter of the grains retained on the screen, in microns, for the Tyler standard screen scale. The last column was calculated from the formula:

$$\text{Average grain diameter} = \frac{8052}{(1.414)^n}$$

where the numerator is the average grain diameter retained on a 3-mesh screen, and the denominator the square root of 2 raised to the power of the ordinal number of the sieve in question.

Sieve No.	Mesh	Opening, Microns	Average Diameter of Grains Retained, Microns
	3	6680	8052
1	4	4699	5694
2	6	3327	4026
3	8	2362	2847
4	10	1666	2013
5	14	1178	1423
6	20	833	1006.5
7	28	589	711.7
8	35	417	503.2
9	48	295	355.8
10	65	208	251.6
11	100	147	177.9
12	150	104	125.8
13	200	74	88.96
14	270	....	62.91
15	400	....	44.48
16	...	....	31.45
17	...	....	22.25

Average grain diameter retained on any screen is according to usual custom assumed to be the average of the width of the openings of the finest screen passed and of the retaining screen. The scale is extended beyond 200 mesh for its theoretical considerations.

Where 50 per cent or more of the sample is retained on 200 mesh, the median diameter is calculated from the cumulative screen analysis as follows: n_1 represents the number of the finest sieve retaining less than 50 per cent cumulative of the sample; n_2, the number of the coarsest sieve retaining more than 50 per cent cumulative of the sample $(n_1 + 1)$; n the number of the hypothetical sieve required to divide the sample into two portions of equal weight.

$$n = n_1 + \frac{50 - \%\text{ cum. on } n_1}{\%\text{ cum. on } n_2 - \%\text{ cum. on } n_1}$$

$$\text{and the median diameter} = \frac{8052}{(1.414)^n}$$

As an illustration, the assumption is made that sieve No. 9 retained 47.1 per cent cumulative and sieve No. 10 55.0 per cent.

$$n = 9 + \frac{50 - 47.1}{55.0 - 47.1} = 9.367$$

$$\text{and the median diam.} = \frac{8052}{(1.414)^{9.367}} = 313 \text{ microns.}$$

The entire calculation may be made with three settings of a slide rule.

Where less than 50 per cent cumulative is retained on 200 mesh an extrapolation is necessary, the accuracy of which decreases as the percentage of minus-200-mesh material increases.

Considering first the case where the percentage through 200 mesh is less than 100 minus the per cent cumulative retained on 150 mesh:

$$n = 13 + \frac{\%\text{ through 200 mesh} - 50}{\%\text{ cum. on 200 mesh} - \%\text{ cum. on 150 mesh}}$$

Where the percentage through 200 mesh is higher than in the case given in the foregoing, but less than 100 minus the per cent cumulative retained on 100 mesh:

$$n = 13 + \frac{\%\text{ through 200 mesh} - 50}{\frac{1}{2}(\%\text{ cum. on 200 mesh} - \%\text{ cum. on 100 mesh})}$$

The extrapolation may be carried to any desired point in a similar manner.

Preventing Silicosis

—by Collecting Drill Dust at Its Source

Jackhammer drills equipped with dust eliminators

SILICOSIS, the most widespread and insidious industrial disease among mine workers, has been the subject of much study, principally on the Witwatersrand, in South Africa, where a noteworthy decrease in its prevalence has been accomplished, chiefly by the adoption of wet drilling. This use of water, however, has not been entirely effective, either in the South African gold mines or in other districts where a highly siliceous rock is drilled. The disease, which has the additional hazard of facilitating the incidence of tuberculosis, and is defined by medical authorities as a fibrosis of the lungs induced by the inhalation of dust containing free silica, is also found among rock drill operators engaged on subway construction and foundation work in New York City, the rock drilled in this locality being a schist with a free silica content up to 84 per cent.

For several years the Metropolitan Life Insurance Company has been studying the silicosis hazard in New York City, with the New York State Department of Labor and the Harvard School of Public Health participating in the investigations. These studies, made under the supervision of Dr. W. J. McConnell, of the company's Industrial Health Section, and J. William Fehnel, chief chemist of the section, have led recently to the development of a device known as a dust eliminator, which will probably prove to be a highly effective instrument in combating silicosis. Tests, with actual dust counts, made under various methods of drilling, including wet and dry drilling, with and without the dust eliminator, show that when the device is employed the dust content of the air is reduced to a minimum, so that it is practically harmless and much below the standards for silica dust that have been established by the U. S. Public Health Service.

The eliminator, which was devised by George S. Kelley, construction engineer of the George J. Atwell Foundation Company, of New York City, is of sturdy and simple construction. As shown in Fig. 1, it resembles in shape

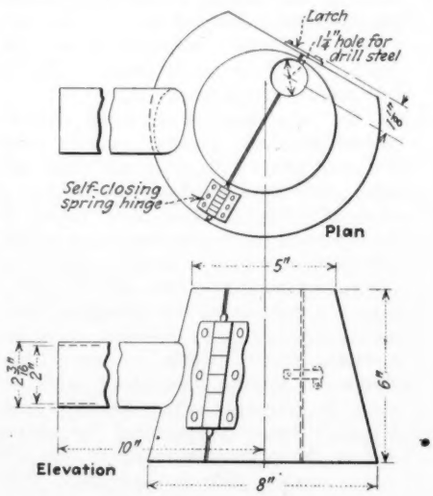


Fig. 1—Details of the dust eliminator

Eight jackhammer drills in operation. Left—Without use of dust eliminators. Right—With each drill equipped with an eliminator. Dust samples were taken during the tests with the two impingers mounted on tripods within the circle of drills

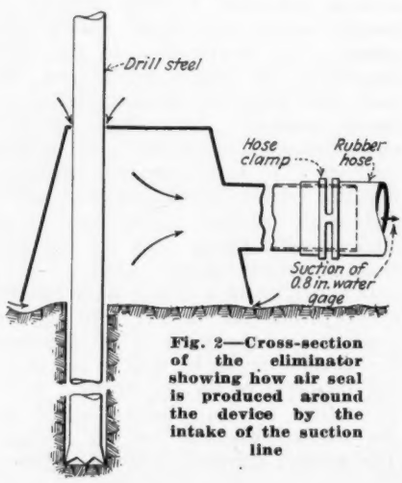
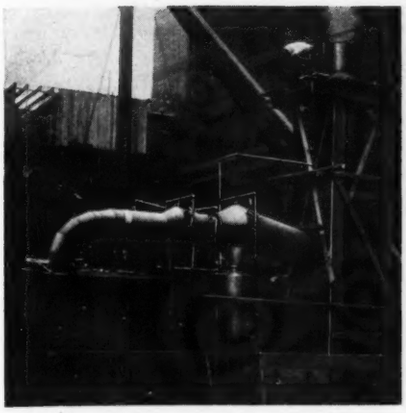


Fig. 2—Cross-section of the eliminator showing how air seal is produced around the device by the intake of the suction line



Dust collecting apparatus applied to removing dust from air discharged by suction lines from the eliminators

a truncated cone, with a flat side. It is fitted with a piece of 2-in. pipe and cut into two halves; these are held together by an ordinary door spring at the back, and a small plate latch in front. The top is a $\frac{3}{8}$-in. steel plate, 5 in. in diameter, electrically welded to the lower part of the device, made of 14-gage sheet iron and with a diameter of 8 in. at the bottom. The pipe is a 7-in. piece of Shelby tubing, $2\frac{3}{16}$ in. outside diameter and 2 in. inside; it is electrically welded to the lower part of one of the halves. The drill steel rotates freely within a $1\frac{1}{4}$-in. hole in the top plate. Owing to the flat side at the front of the device, drilling close to another body is possible, a clearance of only $1\frac{1}{8}$ in. from the center of the hole in the top plate being required.

The effectiveness of the device is based on the fact that the dust produced in drilling, including fine particles that are usually driven into the air, even when wet drilling is employed, is drawn into the eliminator and not permitted to escape into the surrounding air breathed by the drill operator. This condition is achieved by the formation of an air seal around the eliminator, illustrated in Fig. 2, which is produced by a suction of 0.8 in. of water. As soon as the dust produced in drilling enters the device, it is removed through the suction line, at the end of which an innocuous disposal of the dust can be effected by one of various methods.

Practical application of the dust eliminator has already been made in the excavation of the rock foundation for the new building of the Metropolitan Life Insurance Building in New York City, where the accompanying photographs were taken. In this instance, the air suction is provided by a General Electric centrifugal compressor, with a capacity of 3,500 cu.ft. of air per minute at a pressure of $1\frac{1}{4}$ lb. From the compressor, on the street level, the suction line comprises, first, a short length of 12-in. pipe, then a 10-in. line, made of light-weight casing pipe, around the entire lot, which is 200 ft. square. At every 40 ft. in this 10-in. line is a 6-in. outlet, from which a 6-in. hose leads to a distributor, 10 in. in diameter and 32 in. long, equipped with ten 2-in. outlets, as shown in Fig. 3. A 2-in. hose from each of these outlets leads to the dust eliminator of one of the rock drills used in excavating the foundation. On reaching the centrifugal compressor, the dust-laden air passes to a dust collecting apparatus, where the heavier particles are settled first by deflecting the air current around a series of baffle plates. The finer particles are then settled with the aid of water sprays and air filters, the innocuous air discharging into the atmosphere at the exhaust of the apparatus. Various types of dust collectors on the market are being tested at the operation. Selection of the apparatus to be used permanently will be made on completion of the tests.

The principal advantages claimed for the dust eliminator are:

1. By preventing fine dust particles from reaching the air breathed by the drill operator, it renders dry drilling innocuous and makes it much superior to wet drilling as a silicosis preventive measure.

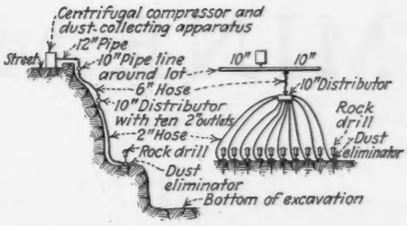


Fig. 3—Piping arrangement employed with the eliminator

2. Inasmuch as it permits the use of the full air pressure available in dry drilling without the operator's experiencing any discomfort from dust, the device tends to increase the efficiency of such operations.

3. Although it has been used only with jackhammers in drilling holes well below the horizontal, the eliminator is said to be readily adaptable to drilling with other types of rock drills and at any angle above or below the horizontal.

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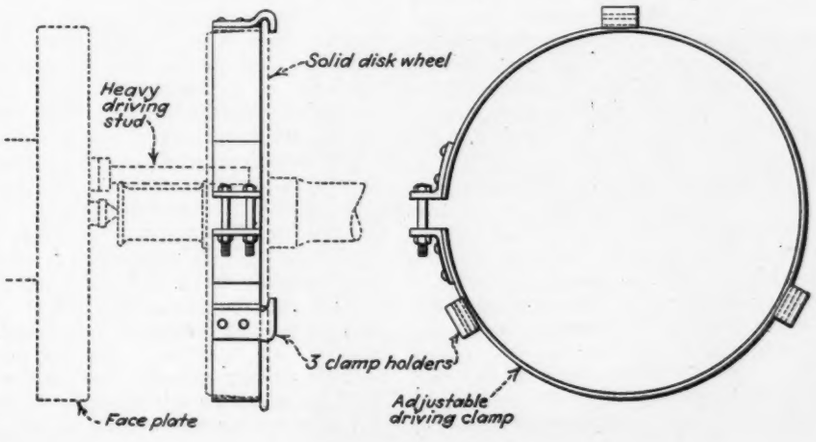
Practical Driving Clamp For Rectifying Car-Wheel Treads

WHEN rectifying the treads of solid-disk car wheels in the lathe the use of an efficient driving device to contact with the driving stub of the face plate is important. The general practice is to secure a solid ring or casing to the tire of the wheel nearest to the face plate—an unsatisfactory procedure because of the solid nature of the casing or ring, necessitating removal of the wheel pair from the lathe when the contrivance is to be changed from one wheel to the other, with consequent loss of time. A device to overcome this disadvantage was recently developed at the machine shop of Nevada Consolidated Copper at Ray, Ariz., the details of which are shown in the accompanying illustration.

The important features of this useful device are, first, its light weight, and, second, the adjustable clamp arrangement, which enables the operator to change the device from one wheel to the other without first removing the wheels from the lathe. Because of the tapered wheel tread, the clamp is provided with three riveted-on holders; these anchor the clamp to the wheel flange and thus prevent slipping.



MINE MAPS:

Their Preparation, Correlation, and Maintenance

D. C. Gilbert

MINING operations are largely dependent on maps, and these have attained increased importance in late years because of the growing use of detailed geologic information for control of operations. Among the great number of large, small, and prospective mines, the methods of keeping essential map data are bound to vary. Some particularly good systems are in use, and also some extremely poor ones. Many small companies consider the subject of little importance, and neglect almost entirely to record facts that may later be of great value.

In the course of mine examinations in Western states, I have had occasion to inspect mining and geologic maps of varying degrees of usefulness, and wish to suggest here certain methods of maintaining essential data, which may be varied to suit individual requirements. That successful mining companies will be influenced to change methods which have been found to be satisfactory is not expected. But inasmuch as every mine or prospect looks forward to important growth, and because this growth must usually depend upon the correct interpretation of geologic data, these should be faithfully recorded upon maps in the most useful manner. Furthermore, an accurate and convenient set of mining maps, together with geologic and assay data, will be found of great value not only during the expected operation of the mine as a producing unit but also in the event of examination for a prospective purchaser, such an examination being greatly expedited if suitable maps are available. Where workings have become inaccessible, the ability to produce carefully prepared geologic and assay data may even swing the balance toward a favorable report, for most examining engineers have learned that the average man's recollection, unsupported by concise data, is not reliable.

A mining property ordinarily embraces a group of claims in an area known as a mining district. Most mining districts contain one or more mines which have been important producers of ore at some time. Because many districts are natural geologic units, and for the further reason that the value of any mine or prospect in a district may depend somewhat upon its relation to geologic features in other properties in the district, that this relation be clearly shown on a map is important. This district map should be of small scale inasmuch as an area of ten or more square miles may be included; moreover, the map should be small enough to be easily handled.

For a particular ownership, maps of larger scale, to show mine workings, assays, and detailed geology, are essential for the economic development of the property. Prior to the discovery of commercial orebodies, these maps may be of simple character, but subsequent to that event, the mine workings may become so ramified that nothing short of a well-planned system can attain the desired goal. And here the statement may be made that this goal should include not only the details which guide the operator in his daily development and stoping problems but also a comprehensive record whereby the essential features of the operation may be readily grasped by a newcomer, even though several years have elapsed since the mine has been active and the former personnel is no longer available. In this latter requisite, mining maps and records are frequently deficient.

Efficient and intelligent control of underground operations depends largely on graphical records that show geologic data, as well as the status of extraction and development operations

In planning a set of maps for a mining operation the selection of map scales should be considered first. If the district embraces a large area, it can be shown in its entirety on a small scale, possibly on a scale of 1,000 or 2,000 ft. to the inch. No details of geology need be attempted on a district map of such small scale, but the generalized geology, property lines, and the positions of major ore channels, faults, and vein systems can usually be reproduced in an instructive manner. As a rule, only surface features will be shown on the district map. For the smaller area that embraces the property in question, together with neighboring mines and prospects the geology of which may have an important bearing upon local development, a larger scale must be adopted. For such maps a 200-, 400-, or a 500-ft. scale is common, inasmuch as those geologic structures which can be projected for several hundred feet can be easily reproduced with these scales. If underground development is shallow or of small extent, a surface map will suffice, but where underground development is deep or extensive, plan maps (horizontal sections) should be made at selected elevations, and on these should be shown the geology, both known and projected.

The scale to be adopted for intimate mapping of the mine workings may now be considered. In the Western United States maps with a 30-, 40-, or a 100-ft. scale are frequently used for this purpose, but maps drawn to a scale of 50 ft. to the inch are in most common use. Maps drawn to a 30-ft. scale are sometimes used at mines or prospects which cover little area, and 40-ft.-scale maps are frequently used at mines which are intermediate in size. A 100-ft. scale is employed chiefly for composites of mine workings and for geologic maps at properties where the structures are simple. Inasmuch as the detailed working maps are used in solving local problems and need not include a large area on one sheet, I prefer to have them made to a 40-ft. scale. The mine workings are then reproduced to such size on the maps that geologic details, assays, and other information may be clearly shown. If these detailed maps are used in conjunction with a set of 200- or 400-ft.-scale maps of the property and adjacent area, and with a map of the entire district drawn on a 1,000- or 2,000-ft. scale, the scale relationships are rational and convenient. The more commonly used scales for related map sets of this description are 50, 200, and 1,000 ft., but in many instances the 200-ft.-scale maps do not embrace a sufficient area on a sheet of convenient size. The more important geologic features can be posted on 400-ft.-scale maps about as readily as on those of 200-ft. scale, but this may necessitate

exaggerating somewhat the width of development headings so that they may be shown by a double line.

Working maps of the mine, especially those on which geology is shown, are usually made on tracing cloth, owing to the fact that one sheet must often be viewed through another in making correlations. The practice of rolling a tracing for filing is satisfactory if the tracing is not in frequent use, or if it is not one of a matched set or "block" of mine maps. Mining maps differ from ordinary surface maps in that a number of matched or related sheets must frequently be used to depict the workings and geology at different elevations in a given block of ground, and, if such maps develop a chronic curl from rolling, they are henceforth handled with difficulty. If progressive map scales, such as 40-, 400-, and 2,000-ft.-scale sets, are used, no single sheet need be so large that it cannot be filed flat in a drawer or other compartment of convenient size. Or each set or block of related maps may be mounted on a fiber backboard, and these filed in the vertical slots of a special cabinet, as shown in the accompanying illustration. In this instance each sheet is 30x40 in., inside of border, and this standard is adhered to for all maps of the three scales which are employed. A special clip allows easy removal of any sheet.

The most simple type of mining map is that used where the deposit is a single, flat-lying bed or blanket vein, such as a coal seam or a tabular, bedded deposit in nearly horizontal strata. Here all workings, including development entries, drifts, or crosscuts, as well as rooms or stopes, may be shown on a single sheet. Where a tabular vein is inclined as much as 60 deg. from the horizontal, a single plan map or horizontal projection may still be used to record all mining and geologic data, although stopes and other inclined workings in the vein will appear foreshortened along the dip. If additional and nearly parallel veins are developed, a separate sheet may be used for each vein. If the mine is exploiting a series of relatively narrow, tabular veins whose individual members dip at 60 to 90 deg., each level of the mine, with its geology and other data, will best be shown on a separate sheet, and stopes and other workings along the veins must be indicated by longitudinal sections on the individual veins.

The preceding examples are relatively simple and involve no difficulty. But, unfortunately for the simplicity of mining maps, many orebodies are massive or irregular or both, and the detailed information which should be desired cannot be shown by any simple map system. Thus, in the metal mines of the Western United States, replacement orebodies in limestone are common, and although these may be quite irregular in shape, they are often closely associated with steep fissure veins, within which are found tabular orebodies of the simple type, previously discussed. In addition, if the strata are relatively flat, they may contain tabular, bedded deposits of low dip. So that, in a single mine, it is not uncommon to find flat tabular, steep tabular, and irregular, massive orebodies, each imposing its own demand upon the map maker. The most common method of dealing with the problem has been to map the development in the mine, either as a composite of all levels or by the use of a separate sheet for each level, and then to indicate the stope outlines thereon. In many instances vertical sections have been added to portray stoping, but in complicated systems of orebodies these are rarely sufficient.

No plan for showing stopes in massive, irregular orebodies has been devised which equals that of frequent horizontal sections, such as the floor sheets or stope books commonly employed in square-set mining. Inasmuch as the square-sets in any mine are of uniform dimensions, the interval between stope floors is likewise a constant, so that the mining and development on each floor may be conveniently plotted from the sets, and the operation in any part of the mine may be studied in detail from the matched stope floor sheets.

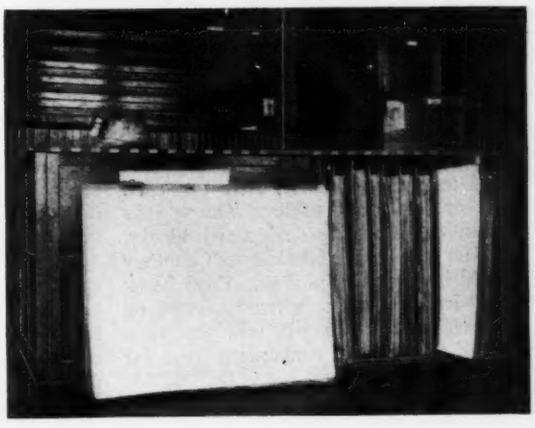
Where the mine is of considerable size and a floor sheet to include the entire stoping area at a given elevation would be cumbersome, recourse may be had to a system of individual stope books, in which the sheets are cross-lined so that each block represents one square-set on the desired scale, with successive floors plotted on successive sheets. Most systems of this type which I have encountered leave much to be desired. To orient the floor plans in stope books with the geologic data on other maps is usually difficult; important geologic features are not always shown on the stope sheets; and, where the sheets are made from opaque material, some difficulty is encountered in making correlations. However, the records maintained at mines where square-setting is the rule are usually superior to those at mines where other stoping methods have been adopted, because regular spacing of timber encourages regularity on the part of the resident engineer or geologist in the mapping and recording of observed conditions. A modification of the system of floor sheets or stope books can be applied readily to any mine where the orebodies are massive or irregular, regardless of the stoping methods in use.

At most mines that contain irregular orebodies, and whose engineering and geologic maps are neither adequate nor convenient, the loss of time in assembling data for the daily guidance of operations more than offsets the cost of an improved system. Moreover, improvement in the exhibition of essential data in the office has been known to result not only in better control of stoping operations but also in discovery of new ore, discoveries being made in sections where the solution of complex geologic structures is essential to good development.

To illustrate the requirements for a good system of maps in mining orebodies of diverse forms, one may consider a hypothetical mine. Imagine the property to have developed a number of large and irregular orebodies, in conjunction with a series of tabular oreshoots in steep fissures, all in limestone beds which are locally folded and faulted. In addition, the property includes several bedded orebodies of tabular form and usually of low dip. The mine, which has a vertical extent of 2,000 ft., has been acquired by a new company that plans further work on known orebodies, as well as a search for new orebodies and expansion of the property into adjacent ground, if such action is found to be advisable. Surveys of all mine workings are available, but the maps are in poor condition, and the first task is to build convenient map sets, whereon geology may be shown, and which may be used to the best advantage.

The standard tracing sheet chosen for the geologic maps is 30x40 in. inside of border, and, after this preliminary decision the map sets to be employed are determined. A description of these follows:

The district maps will include one



Geologic map file at the property of the Utah Delaware Mining Company, at Bingham, Utah

1,200-ft.-scale map of surface geology and topography, and a corresponding map to show property lines and a composite of all mine workings in the district. Because considerable development has been done in the district, a third sheet is added to show all levels and geology at or near a fixed elevation which has an average depth of 1,000 ft. below the surface. An additional 30x40-in. tracing sheet is used for vertical sections across the district, several of which can be placed on a single sheet, as the scale permits a vertical range of 3,600 ft. in three inches. These four sheets, comprising the district map set, are matched and mounted on a fiber backboard by special clips. They will be used in the search for new areas to be prospected.

For the purpose of viewing the workings and outstanding geologic features of the mine and its immediate neighbors, a set of 400-ft.-scale maps is made on standard 30x40-in. tracing sheets. This set of local correlation maps includes: (1) a sheet showing topography and surface geology; (2) a sheet bearing property lines, a composite of all mine workings in the area, and the "layout" of the 40-ft.-scale blocks, described below; (3) a separate geologic sheet for each principal mine level. These plan maps, drawn to a 400-ft. scale, are matched and mounted on a fiber backboard. Following a preliminary study of these plans, vertical sections are "cut" through the area, and shown on the standard 30x40-in. sheets. A separate fiber backboard is used for the sections, so that the 400-ft.-scale plans and sections may be studied simultaneously, without the necessity for frequent removal of the map sheets from their mountings. The 400-ft.-scale set will be used chiefly for correlating the principle features of local geology, and for the study of undeveloped sections of the mine.

The scale selected for detailed maps is 40 ft. to the inch. Upon the 400-ft.-scale composite sheet "blocks" are selected, within which the workings will be shown in detail, using standard 30x40-in. tracing cloth sheets, and allowing each block to overlap the adjoining blocks for a space of 2½ in., equal to 100 ft. in the mine. To cover the entire area of the mine with 40-ft.-scale blocks will not be necessary, because the blocks are required only in those portions within which greater detail is essential. The overlap of 100 ft. will be found invaluable when adjoining map sets are to be compared. A separate sheet will be used for each level or important sublevel which falls within each of the designated blocks, and on these the details of geology should be carefully plotted. Each block of 40-ft.-scale maps, when mounted on its own fiber backboard, will present a unit of the mine in convenient form for careful study.

For the solution of local problems, 40-ft.-scale vertical sections will next be required, but in mines where geologic structures are complex these should rarely be laid out on a regular system. In the present instance the sections will be cut where they will be most beneficial, and each set of adjacent sections will be mounted on an individual fiber backboard.

Stope books, to be prepared next, will consist of a cover with binding posts to hold sheets of tracing cloth, on which the mine coordinates are ruled to the scale of 40 ft. to the inch. The individual sheets represent horizontal sections at 7.7-ft. intervals, this being the vertical distance between floors of both square-set stopes and timbered raises. A single book will hold 50 to 60 sheets, or a vertical range of 400 ft. The top or first sheet in the book represents a portion of a mine level in the block covered by the book, complete with details of workings and geology. Successive sheets, down to that of the next lower level, represent horizontal sections of the stopes and other workings at intervals of 7.7 ft., regardless of either the form of the excavation or the mining method in use. Where square-sets are employed, they will be shown in proper orientation. Important geologic features will be shown on these floor sheets, the scale being large enough to permit the addition of condensed assay results. Data on ore not mined, either small streaks or larger quantities of low-grade material, are of particular importance. The month or year of mining may be recorded on the plans by the addition of light, colored-pencil shadings, if such additions are deemed important.

In the daily operation of the mine, and in the search for new oreshoots adjacent to older stopes, the stope books will be of great value, for not only may accurate data be obtained readily with them, but the relationship between the orebodies and their controlling geologic structures will be more easily recorded and determined. In those parts of the mine where stoping is confined to relatively flat, tabular orebodies, the stope book would perform no useful function, and such workings may best be shown by more simple methods. Small, flat stopes may be shown on the regular 30x40-in. geologic plans, or, in the event one or more flat veins are stoped over large areas, special maps may be made to illustrate them. Similarly, in areas where stoping is confined to relatively narrow, tabular shoots in steep fissures, no necesisty for stope books will prevail if longitudinal sections can be used for posting the essential stope data.

During the operation of the mine little difficulty should be experienced in maintaining the various map sets described. The geologist will post the 40-ft.-scale plans and sections as frequently as may be necessary for the geologic control of working places. If the mining operations are extensive, the mine sampler or a young engineer who desires geologic experience may soon be entrusted with the recording of geologic data obtained in the stopes. The 400-ft.-scale plans and sections should be brought to date every few weeks, so that important correlations and projections will not escape notice at critical times. Addition of new data to the 1,200-ft.-scale district maps may not be required more frequently than once each year.

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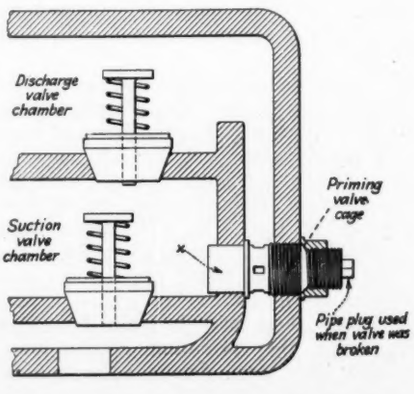
Sinking Pump Repair

UNSATISFACTORY performance of a sinking pump purchased from a neighboring company and overhauled at some distance from the general repair shop, was a constant source of trouble, writes T. C. Hulton, master mechanic, Cia. Minera Chambas, Abras Grandes, Cuba. Installed for sinking duty at different units, the pump worked satisfactorily on low lifts, but had to be replaced by a standard Cameron pump as shaft sinking operations progressed, and the pump lift increased—faulty priming causing a constant loss of pumping capacity.

When the pump was sent to the general repair shop for investigation a thorough inspection of the valve chambers revealed that the priming valve—lost or damaged at one time—had been replaced with a pipe plug, which permitted water to pass from the discharge to the suction chamber. With no spare priming valve available, the difficulty was temporarily overcome by tapping the priming valve cage at "X" to accommodate a ¾-in. plug, as indicated in the accompanying sketch, until a new valve could be ordered from the factory.

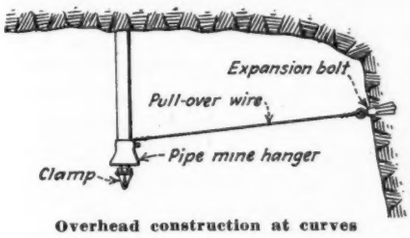


Conductor Tension in Electric Haulage

Gypsum property in Ohio adopts precautionary methods in the design of an overhead contact system in its main haulageways. Six years of operation has resulted in negligible slackening of the wire, with obvious economy and operating advantages

MANY factors contribute to slack trolley wire, some of which may be controlled and some of which are beyond control, writes L. W. Birch, engineer, transportation department of the Ohio Brass Company. Leaning and unsound supporting poles, broken guy and pull-over wires, the effects of slides, wind, and fire, may all be overcome; but the invariable daily temperature changes produce a shortening and lengthening of the trolley wire, which causes slackening.

The change in length of a definite

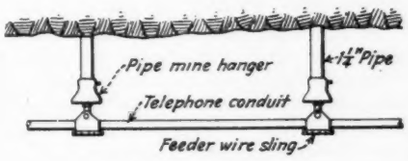


Overhead construction at curves

trolley wire span owing to expansion and contraction is not only the slack produced in itself but is the cause of greater permanent slack creeping into the span. Unfortunately, copper has no definite yield point. With the slightest load a copper conductor stretches—very little, it is true—and a definite stretching is going on even though the load on the conductor is below the accepted theoretical yield point. For designing and erecting purposes, the associations dealing with electrified haulage have chosen for the yield point of hard-drawn copper trolley wire a figure representing one-half the breaking load. This yield point should, under no circumstances, be exceeded under normal conditions of operation. The maximum working load in a contact wire never exceeds twice the normal load value—that tension prevailing in the trolley wire at normal tension (60 deg. F.). If the copper trolley wire could be erected in a location of constant temperature, no expansion and contraction would result from temperature change, and stretch would be attributable only to its load. If, however, temperature changes take place, tensions greater than normal will be experienced, and greater permanent stretching of the trolley wire is possible.

All outside haulage is subject to considerable temperature change and subsequent trolley-wire slack. Fortunately, outside haulage is neither hampered for lack of head room nor is maintenance impeded by trip passages. Slack can be constantly "cut out" of the trolley wire on outside haulage, but a better remedy would be to regulate it. Temperature cannot be regulated. Consequently, the permanent stretch condition in the contact wire is to be expected. Several types of bronze trolley wire are available that have definite yield points, and accumulate little permanent stretch. These wires will carry less current than hard-drawn copper, but this condition may be offset by auxiliary feeders, which can be strung in the unrestricted space surrounding outside haulage tracks.

Conditions inside the mine are radically different. Head room is restricted, trip passages hamper maintenance, and many other physical difficulties contribute to the worries of the overhead man. But to offset some of these restrictions, the underground mine usually maintains a constant temperature, summer and winter. Conditions are not favorable for slack trolley wire.



Telephone suspension

In 1925, the United States Gypsum Company electrified the main haulageway of its mines at Gypsum, Ohio. The seam of gypsum in this section permits ample head room for an overhead distribution system, and sufficient space for track elevation and ballasting. The main workings of this mine are about 75 ft. below the surface, at a constant temperature of about 55 deg. F., summer and winter. The main haulageway is equipped with one 6-ton, 250-volt, direct-current locomotive, which handles 30 two-ton cars per trip. Gathering is accomplished with mules. With this type of electrical load the "4/0" grooved trolley wire supplies the necessary energy to the locomotive over the mile of haulage, with only one borehole auxiliary feeder tap.

The overhead contact system is constructed with 4/0 grooved hard-drawn copper trolley wire, suspended at 25-ft. intervals on tangent, and with reduced spacing on curves. Extra heavy 1¼-in. galvanized pipe, held in a drill hole in the roof with a wooden plug, supports an insulated mine hanger at its lower end. To the hanger is attached a mechanical trolley-wire clamp, the jaws of which are opened or closed by operating the clamping nut. Curves are held in alignment by attaching a pull-over wire to the vertical pipe immediately above the mine hanger, and anchoring the pull-over wire to an expansion bolt in the side wall.

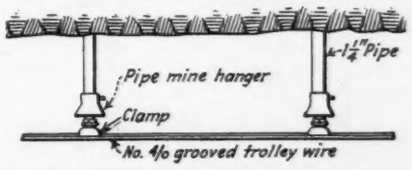
After six years of operation, with motor passes under the trolley wire varying from 30 to 60 daily, the tension in the wire has been maintained. No slack sections exist in the overhead system, and no perceptible pounding of wire at the clamps has been detected. The 4/0 contact wire shows slight wear. This remarkable condition may be attributed to three factors:

1. Proper tension was placed in the trolley wire during erection.

2. The extended pipe construction, although rigid vertically, afforded horizontal flexibility in the overhead system.

3. Temperature conditions in the mine were constant, thus avoiding the fluctuations which aid in stretching the trolley wire.

Although this mine is below the level of Lake Erie, it is not an unusually wet mine. However, moisture carries down over the outside shell of the insulated hanger and forms small stalactites of calcium sulphate on the rim. In some instances the deposit has covered the face of the insulation. No insulation breakdown has occurred, and the power



Overhead construction on tangents

leakage at the switchboard with all load shut is negligible.

Telephone, light, and signal circuits at the mine bottom are inclosed in conduit, suspended, and insulated from the roof with pipe and insulated hangers, much as is the trolley circuit. Feeder-wire slings are attached immediately to the conduit and screwed to the hanger. The 40-lb. main-haulage rail is bonded with compressed terminal copper bonds. Owing to the well-surfaced and ballasted track, bond failures are almost unknown.

Mining in British South Africa

W. B. Timm

THE author, chief engineer of the division of ore dressing and metallurgy, Mines Branch, Department of Mines, Dominion of Canada, has recorded a series of impressions gained during a tour through the Union of South Africa and Southern and Northern Rhodesia. The principal mining areas visited included the diamond fields of Kimberley and the Premier mine, at Cullinan; the gold fields of the Witwatersrand and the eastern Transvaal; the platinum occurrences of the Transvaal in the vicinity of Rustenburg; the lead-zinc-vanadium mines of Broken Hill, Northern Rhodesia, and the copper fields of Northern Rhodesia. This article is an abstract of a paper, an excellent monograph on the subject, originally presented before the Canadian Institute of Mining and Metallury, and subsequently reproduced as Memorandum No. 46, of the Department of Mines, Ottawa, Canada.

A VISITOR to South Africa is impressed with the extent, magnitude, and character of its mineral deposits. Notable among these are the volcanic pipes in which the diamonds occur; the gold-bearing reefs of the Witwatersrand and eastern Transvaal, and the platinum-bearing Merensky reef of the Bushveld igneous complex, extending for miles. The reef for the most part dips at comparatively flat angles and underlies great areas. Equally interesting are the methods employed in the mining of the ore from the flat-lying and narrow reefs; the high-grade nature of the chrome and manganese beds; the many occurrences of asbestos-bearing rocks containing a high percentage of long-fiber material; the great minable widths of the extensive coal measures, and the extent and magnitude of the copper-bearing synclinal reefs of Northern Rhodesia. One receives a lasting impression of these outstanding features of the mineral industry and especially of its dependency on the native for the successful operation of the mines.

The salient impressions of the mineral industry of British South Africa may be summarized as follows:

1. The mineral industry is the chief industrial asset of the Union of South Africa and of Southern Rhodesia, and it will soon attain the same status in Northern Rhodesia.

2. Reserves of diamonds in developed mines are sufficient to maintain production for a century. Many pipes have not been developed. The output is dependent on the world's market; the value of production, on keeping control of that market.

3. Reserves of gold ore are sufficient to maintain production at approximately the present rate for the next ten to twenty years. As much gold should be taken from the reefs of the Rand as has been already produced.

4. Immense reserves of platinum exist in the norite of the Bushveld Igneous Complex. Production will be limited to what can be disposed of profitably. The operating costs seem to be around $35 to $40 an ounce.

5. Great reserves of iron and coal are available in the Union, and large quantities of chrome and manganese. All raw materials for the building up of an iron and steel industry are present.

6. Important deposits are known of non-metallics such as asbestos, mica, fluorspar, corundum, barytes, phosphate, gypsum, magnesite, dolomite, limestone, salt, soda, nitrates, building stone, silica sands, clays, and talc.

7. Although gold is the chief item in the mineral production of Southern Rhodesia, large reserves of chrome and asbestos have lately enabled this country to attain a commanding position in the world's markets for both these minerals. The coal reserves of the northwestern portion of the colony are extensive.

8. Enormous reserves of copper ore in Northern Rhodesia will have an important bearing on the world copper situation in the next decade.

9. Deposits of tin, lead, zinc, nickel, cobalt, molybdenum, tungsten, and vanadium in the Union and the Rhodesias occur in quantities sufficient for domestic requirements and industrial expansion.

10. The mineral industry of Africa has depended on its native population for the successful exploitation of its mines, and in the production of gold the skill and stamina of the Negro workers alone makes possible the mining of the narrow reefs and operations at great depths and in tropical climates.

The rapid advance of the mining industry of South Africa started with the discovery of the world-famous diamond fields at Kimberley in 1870. Since then, diamonds having a value of about $1,500,000,000 have been produced. The annual production, of between four and five million carats, is obtained from the volcanic kimberlite pipes in the vicinity of the Orange River and its tributaries, and from alluvial ground from the erosion of the upper portions of the pipes. Of some 150 pipes so far discovered, 25 have been mined, and the bulk of the production comes from seven. The diamond content of the kimberlite, even in

At its N'Kana mine, Northern Rhodesia, Rhokana Corporation has built this handsome hospital

the richest pipes, is small, ranging from 6 carats to 35 carats to the ton, equivalent to from one in four million to one in seven million. Kimberley blue ground contains approximately one grain of diamond per ton, or one part in fourteen million. As a general rule the diamond content diminishes with depth.

The pipes, generally ovoid in cross-section, larger near the surface, vary in size from more than a half-mile across the greatest diameter, as at the Premier mine, Cullinan, near Pretoria, to less than 100 ft. In vertical section they are for the most part steepsided vertical funnels, worked to a depth of 3,520 ft. at the Kimberley pipe. Mining is begun on all pipes by the open-cast method, and the removal of the pay-ground to the surface by overhead bucket haulage and by mechanical truck haulage through an incline is similar to the mining of asbestos rock in Quebec. When depths are reached beyond which this system cannot be employed, underground mining is used. Two main vertical shafts are sunk in the country rock about 1,000 ft. from the pipe. One shaft is used for hoisting, the other for ventilation and emergency. From the hoisting shaft, main-haulage levels are driven to the pipe at intervals of 600 ft. On these main-haulage levels the pipe is developed by a rectangular system of main cross-drives. The ground between is developed by prospect shafts, one usually in the pipe and one in the country rock adjacent to it. Working levels are developed 40 ft. to 60 ft. apart in the blue ground, by a rectangular system of drives, which eventually cuts the ground on each working level into pillars 20x20 ft. Ore passes connect with the main level below. The method of mining is one of caving and retreating toward the section of the mine nearest the main haulage shaft.

The process of extraction is to reduce the blue ground to a size small enough to insure separation of the diamond. In some cases the blue ground is spread out and allowed to weather and disintegrate before concentration. The stages of concentration are as follows: Reduction in gyratory crushers and rolls to 1¼ in.; concentration in rotary washing pans. The concentrate, representing about 2 per cent of the original feed and ranging in size from 1¼ in. to sand, is carefully graded into definite sizes, and each size is fed to its own pulsator jig. Jig concentrate from each jig is passed over its own grease table, the diamonds adhering to the grease on the upper six inches of the table. At intervals a table is stopped and the grease containing the diamonds is scraped off. The grease is melted away from the diamonds in boiling water and the diamonds are collected, dried, and graded by experts.

The cost of mining and treatment is about 75c. per ton by the open-cast methods at large-scale operations such as the Premier mine, and up to $1.50 per ton by underground methods in the Kimberley field.

Main shaft and mill buildings at Roan Antelope, in Northern Rhodesia

Of the world's annual gold production the Union of South Africa produces 53 per cent, or over $200,000,000. Nearly all of this comes from the famous Witwatersrand gold fields, commonly known as the "Rand." Osmiridium to the value of $400,000 and about 1,000,000 oz. of silver are recovered annually from the gold bullion produced. The annual Rand tonnage of ore hoisted is over 36,000,000 tons; of ore treated over 30,000,000 tons; and the recoverable value per ton is about $6.60. Average working costs are about $4.65 per ton, leaving an operating profit of $1.95. To date the Rand has produced gold to the value of more than $5,000,000,000. No other gold field has had a like history. The payable field covers a length of almost 70 miles, and a depth of 7,500 ft. vertical has been reached. Of the production, 75 per cent is now coming from the flat-lying reefs of the eastern section, where depths are not so great and greater widths of reef are mined. This area holds greater promise of maintaining production. To what depth mining will be carried depends on the assay value of the gold-bearing reefs over minable widths, the efficiency of new engineering devices, and the nature of and future financial burdens imposed on the mines by the State.

The ore comes from thin sheets of conglomerate, which, although they vary in gold content, are so remarkably persistent that mine development can be devised for handling large tonnages. Twenty-five mines crush more than 600,000 tons annually; five, more than 1,200,000 tons; and two, over 2,400,000. These large operations have made for large-scale investigations and research into improvements in mining methods. With the free exchange of technical information, the results of such investigations are quickly applied to operation on the Rand as a whole. The co-operation that exists, especially in the pooling of information, among the large number of technically trained men engaged in every phase of mining activities, is responsible to a notable extent for the deep mining operations so successfully carried out on these narrow reefs.

Among difficulties encountered in the mining of the Rand ores are the great rock pressures at depth, the high temperatures at the working faces, and the humidity of the atmosphere necessary to control excessive dusting. Timber is the chief support in most of the mines. It is used either green or impregnated with zinc sulphate as a preservative. The timber is used generally in the form of cribs filled with waste rock, but single props are not uncommon. In the East Rand the timber cribs are being replaced by concrete disks with a timber capping. Waste rock is used for filling. In the flat-lying reefs, sand filling is being adopted. Sands from the old tailing piles are being delivered underground through boreholes put down for that purpose.

The metallurgy of the Rand ores is comparatively simple. The common method of treatment is coarse crushing in jaw and gyratory crushers, followed by heavy stamps. Fine grinding is done in tube mills, coarse ore of a suitable size above 5 in. being used as grinding media. Amalgamation and blanket concentration are employed in some mills to recover osmiridium. Sand and slime leaching with cyanide solution are generally practiced. The only mill operating on all-slime process is at West Springs, in the Far East Rand, but any new milling plants will probably be of this type.

With the exception of three mines, electrical power for the Rand is supplied by the Victoria Falls & Transvaal Power Company from five generating stations, including the station at Witbank owned by the Electricity Supply Commission. The total capacity of these stations is about 425,000 hp. This power is developed from steam produced by the use of slack coal. The company also sells compressed air from thirteen compres-

sors, all of the centrifugal type, eight steam-driven and five electrically driven. Total capacity when compressing to 112 lb. per square inch is 416,500 cu.ft. of free air per minute. The net cost of energy to the mining groups is about 0.8c. per unit, or kilowatt-hour, for electricity, and 2.25c. per 1,000 cu.ft. of free air delivered at an average gage pressure of about 105 lb. per square inch.

Production of platinum in 1930 was 47,021 oz., valued at $1,600,000. This production was from the Bushveld igneous complex, which occupies an eliptical area of 280 miles by 150 miles in the central Transvaal. The outside rim of the complex consists of norites and allied basic rocks and the central portion of granites, granophyres, felsites, basalts, and tufts. The norite occurrences attain a maximum thickness of 2½ miles, the horizontal width being 5 to 12 miles. They dip from 5 to 50 deg. toward the central position of the complex.

The norite sheet is composed of superimposed layers of variable composition. Platinum occurs in the norite associated with chromite in the Merensky reef; with magnetic nickel-iron sulphides; in dunite deposits and pipes; and in many other ways. The dunite pipe occurrences are not promising. Several of these have been worked, but the grade of the ore has diminished with depth, and some have been closed down. The chief source is from the Merensky reef, payable areas of which have been explored for many miles. The total amount of platinum metals actually present in the Merensky horizon is very large—enough to supply the world's need for an indefinite period. Much of the reef is too low grade to be economic. Great sections, contain, however, an average of 0.2 to 0.25 oz. per ton, which is close to the margin of economic operation under present market conditions. Unless high-grade ore is discovered, the future of the platinum industry in South Africa depends largely on price control above $35 an ounce.

Gravity concentration and flotation methods are used for the recovery of the platinum minerals. For gravity concentration on tables a very close classification is necessary. Slime is concentrated on blanket tables. Primary concentrate is collected, classified, and redressed on sand and slime tables. About 50 per cent recovery is made on the oxidized ore. By further concentration by flotation methods the recovery can be increased to 60 per cent. On the unoxidized ore of the lower portions of the reef, recoveries of 80 to 85 per cent can be obtained.

High-grade chrome ore at the rate of 60,000 tons per year, having a value of $450,000, is being produced from a lower chrome band to that of the platinum in the norite of the Bushveld igneous complex. The largest and richest deposits are in the Lydenburg district, but important deposits also exist in the Rustenburg district. The chromite seams, which can be traced for miles, range from 1 in. to 14 ft. thick. The ore, shipped through the port of Lorenco Marques, is of lower grade than the Rhodesian chrome and higher in iron oxide. It has an average composition of 43 per cent chromic oxide and 28.5 per cent iron oxide. The principal mines are operated by the Chrome Corporation (South Africa).

Occurrences of nickel-copper sulphides are being explored in the norite of the Bushveld igneous complex. This large mass holds promise of inclosing extensive deposits of economic minerals.

Important economic occurrences of cassiterite in the Union are associated with the rocks of the central portion of the Bushveld igneous complex, such as granites, granophyres, felsites, and quartzites. The chief deposits, adjacent to the main line of the South African Railways from Pretoria to Pietersburg, occur in pipe deposits of altered red granite at the Zaaiplaats and Groenfontein mines; in pipe and replacement deposits of altered coarse red granite or granophyre at the Mutue Fides and Stavoren mines; and in lode deposits in the sedimentary quartzite at the Rooiberg and Loeuwpoort mines. In the first two types of deposits, the cassiterite is coarsely crystalline and comparatively free from impurities, so that exceptionally high-grade concentrate (from 70 to 75 per cent metallic tin) can be produced from the ore, which averages 1.25 to 3 per cent tin. In the quartzite deposits with an average grade from 1 to 1.5 per cent tin, the cassiterite, more finely crystalline, is associated with considerable pyrite, chalcopyrite, magnetite, and hematite, making concentration more difficult. Recovery is not over 65 per cent. Production in 1930 was 1,234 tons of 69 per cent concentrate, worth about $600,000. The value of the total production to date is approximately $35,000,000.

Occurrences of copper in the Union are confined to Namaqualand — the northwest corner of Cape Province—and Messina, the Northern Transvaal. Interest is again being taken in the possibilities of the Namaqualand field, which started producing in 1852.

At Messina, Northern Transvaal, the copper lenses occur in a brecciated band from 500 to 1,000 ft. wide, extending for about 15 miles in the ancient gneiss and granitic rocks. The copper minerals are chalcopyrite, chalcocite, and bornite. The Messina (Transvaal) Development Company operates the mines, a 1,000-ton concentrator, a smelter, and a refinery, and ships copper ingots containing 99.8 to 99.9 per cent copper to European markets, chiefly through the port of Lorenco Marques. The ore as mined contains about 3 per cent copper. By sorting the grade is raised to 3.8 per cent. It is concentrated on jigs and tables and by flotation to over 40 per cent copper. The concentrate is smelted in a reverberatory furnace to a 65 per cent copper matte, which is converted in a stationary converter to blister copper, and refined into ingots of high purity. Production in 1930 was 9,754 tons, averaging 93.8 per cent copper, worth $2,500,000.

Large deposits of iron ore occur in the Union. Estimates of the probable ore reserves are as follows: High grade, of over 60 per cent iron and from 1 to 5 per cent silica, 120,000,000 tons; medium grade, between 40 and 60 per cent iron and from 5 to 25 per cent silica, 6,000,000,000 tons; titaniferous ore, containing 40 to 50 per cent iron and from 10 to 20 per cent titanic oxide, 2,000,000,000 tons. Deposits of high-grade ore, similar to the Lake Superior type, exist in the Rustenburg area of Transvaal, 120 miles from Pretoria, where the Union government has decided to establish an iron-and-steel industry. The ore is hematite of great purity and of bessemer grade. Replacement deposits of high-grade hematite occur in the brecciated banded ironstones in the Postmasburg area, west of Kimberley.

Extensive sedimentary deposits of medium-grade ore occur in the Pretoria series, outcropping near Pretoria and in the Karoo system in northern Natal. In the Pretoria series a bed of oölitic ironstone from 5 to 27 ft. wide can be traced for many hundreds of miles. This remarkable bed is a magnetic quartzite deposit containing, on the average, 48 per cent iron and 20 per cent silica. A narrow persistent bed of clayband ironstone of an average thickness of 20 in., situated 160 ft. to 180 ft. above the magnetic quartzite, consists of magnetite-chamosite-siderite-oölite, containing over 50 per cent iron and less than 8 per cent silica.

In the Karoo system of northern Natal, in the districts of Dundee and Newcastle, a deposit of stratified iron ore occurs underlying the coal measures, the horizon being 150 to 250 ft. below the main coal seams. The principal outlier is the Prestwick deposit, which supplies at present the ore for the one primary iron producer, the Union Steel Corporation at Newcastle. Small outliers of the Dundee-Newcastle deposit are valuable fluxing material for the high siliceous ores, on account of the high proportion of lime and carbonaceous matter. These outliers of dolomitic ironstone contain 25 per cent iron, 32 per cent lime, and 2.5 per cent insoluble.

The titaniferous deposits, probably the greatest deposits of their kind in the world, of igneous origin, are confined mainly to the Bushveld igneous complex. They contain small amounts of vanadium. Although of no great importance at present, on account of smelting difficulties, they represent an enormous iron-ore reserve.

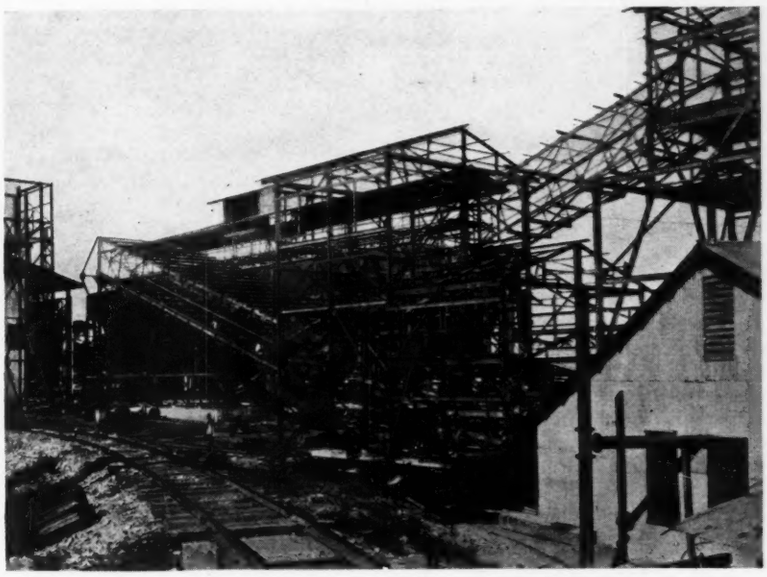
An interesting discovery in recent

years in the Union has been the manganese deposits near Postmasburg, in the Gamagara hills about 100 miles west-northwest of Kimberley. The deposits are extensive, outcropping along the crest of the hills for 40 miles. Where exposed, the ore occurs as a layer or sheet from 5 to 20 ft. thick and contains a manganese content of from 45 to 60 per cent, with an average of about 50 per cent, low in deleterious elements such as phosphorus, sulphur, and silica. Owing to its hardness it is able to stand shipment without the production of much fine material. The deposits, probably the largest in the world, are controlled by Manganese Corporation. The railway has been extended west from Kimberley; a large crushing and sorting plant has been built to reduce the ore to 5-in. for ease of handling; and a loading plant erected at Durban, with a storage capacity of 50,000 tons. Production has started. Smelting works are proposed at Colenso, for the manufacture of ferromanganese and other ferroalloys, where the Electricity Supply Commission has one of its larger power stations. Provision is made for the mining of over 2,000 tons of ore daily, so that the Union is likely to become an important producer of manganese. In March, 1931, 15,199 tons of ore, worth $70,000, was shipped.

South Africa has come forward in recent years as a producer of asbestos. Five varieties occur in the Union: chrysotile, crocidolite, amosite, tremolite, and asbestic. Only the first three are of importance. In 1930 the production was about 20,000 tons, worth about $1,692,000. The principal occurrences of the chrysotile variety are in eastern Transvaal, Swaziland, and Natal, where extensive areas are underlain by serpentinized basic rocks, similar to those in which the chrysotile of the New Amianthus, Kalkkloof, and Havelock mines is found. The principal occurrences of crocidolite, or Cape blue asbestos, are in Griqualand West near Priesha, on the Orange River, Cape Province; and of the amosite, or Cape white asbestos, in the Lydenburg district of Transvaal, where the amosite veins lie in banded ironstone of the Pretoria series.

At the New Amianthus mine, controlled by Turner Brothers Asbestos, the fiber-bearing serpentine has an average width of 7 ft. and extends along the strike for 2,000 ft. About 100 tons of rock is being mined daily, containing about 17 per cent, of which 5 per cent is long fiber, or No. 1 crude. The separation of the fiber from the rock is similar to Canadian practice.

The richest and most extensive corundum fields in the world are in Northern Transvaal. Important deposits of barite occur in Cape Province. The Union has become an important producer of fluorspar. Mica of excellent quality occurs in the Pietersburg district of Transvaal, small tonnages being produced. Large deposits of rock phosphate, gypsum, magnesite, dolomite, and limestone also occur. The salt pans are worked for their salt and soda contents. Nitrates have also been found. Building stone such as granite, syenite, norite, dolerite, diabase, limestone, dolomite, marble, sandstone, and slate occur in abundance. Silica sands, suitable for ordinary glassware; molding sands; clays for ordinary brick and tile purposes; kaolin for pottery; fireclays for refractory bricks; and talc for various uses, including engineer's chalk, heat, and electric insulators, filler for paper and rubber, and toilet powder, are all produced within the Union.



Conveyors that will feed the new 10,000-ton mill of Rhokana Corporation at the N'Kana mine, Northern Rhodesia

Nine gold mines in Southern Rhodesia produce over 10,000 oz. annually, representing 73.5 per cent of the total gold production of the colony. Many smaller mines produce less than 10,000 oz. They are mostly worked by individuals with small capital. The gold occurs in a variety of lode formation, associated with iron pyrites and galena, or with arsenopyrite and stibnite, or copper pyrites, in schistose rocks that are older than the great granite masses intrusive in the schists, and widely distributed over the country. The usual milling practice is crushing with gravity stamps, amalgamation, in certain cases regrinding in pans or tube mills, concentration on tables and blankets, and cyanide treatment of the tailing and slime.

The growth of the asbestos and chrome industry in Southern Rhodesia has been phenomenal. In terms of the world's output of asbestos, Rhodesia is second (Canada being first). She is already the largest producer of crude fiber. In a few years she may be the leading producer in all classes of fiber combined. Large areas, considered unpayable a few years ago, are being developed. The 1930 production was 40,110 tons of fiber, having a value close to $5,547,300. The chief producing areas are in the Bulawayo mining district, including such properties as Shabani; Nil Desperadum, in the Belingwe area; the Pangana mine, in the Filabusi area; in the Victoria mining district, including such mines as the Gath and King, in the Mashaba area; and in the Lomagundi district. The asbestos is all of the chrysotile variety and occurs in intrusions of dunite, altered to serpentine and talc schist, and in the Great Dyke of norite. The chief producing mines are controlled by Turner Brothers Asbestos.

Southern Rhodesia is the world's largest producer of chrome ore. In 1929 the production was close to 300,000 tons, no less than 65 per cent of the total world's output, having a value of $3,350,000. Her chrome ore is in demand, being high grade, easily reaching the standard requirement of 48 per cent Cr_2O_3. The Selukwe deposits are most important, producing over half the output, although the higher chrome content of numerous occurrences along the Great Dyke is bringing these into prominence.

Chrome at Selukwe occurs in large irregular lenses in talc schist and serpentine, derived from the alteration of the dunite intrusions. The chrome lenses are quarried, but underground methods have recently been introduced. The ore, for the most part hard and lumpy, averages 50 per cent Cr_2O_3 and is shipped as mined. In one quarry, where the ore is richer, it is more friable and becomes mixed with dirt. It is put through a Hardinge mill and passed over shaking tables, from which a high-grade product is obtained.

The Great Dyke deposits are narrow

seams of chromite in the norite up to 30 in. thick, the average being 7½ in. The seams dip inward from the margins of the Dyke at angles from 10 to 45 deg. They are soft and crumbly, but are of higher grade than the Selukwe chrome, containing 50 to 52 per cent Cr_2O_3. They are worked from the surface by the open-cast stoping to a depth of 10 ft., when underground resuing methods have to be resorted to from inclines. A depth of 150 ft. has been reached. This method of underground mining has proved that the narrow chromite seams can be profitably worked, even under existing transportation difficulties. The Southern Rhodesia chrome ore is shipped to world markets through the port of Beira, in Portuguese East Africa.

Mica in payable quantities and of excellent grade is mined in two areas in Southern Rhodesia—the Miami area, in the northern part, and the Rusambo area, in the northeastern part. The value of the production for last year was $400,000, for about 200 tons. Copper occurs in several localities. Silver is produced from the gold bullion, and tungsten is also a byproduct of the gold mines. Iron of good quality occurs in many parts of the country, the only production in recent years being as a flux for the copper smelters. Tin is worked on a small scale. Diamonds and other precious stones are found in the alluvial deposits near Gwelo. Arsenic is produced as a byproduct of the arsenical gold mines and is used mainly as a constituent of cattle dips. Barite is produced in the Gwelo district. There are large deposits of corundum, the difficulty being in marketing this mineral. Nickel and platinum occur in the Great Norite Dyke, a unique body of igneous rock over 330 miles long and of a maximum width of 6 miles, which traverses the country in a north-northeast direction.

The lead-zinc-vanadium deposits at Broken Hill, Northern Rhodesia, were discovered in 1902. Operated by Rhodesia Broken Hill Development, these mines have been the chief source of the mineral production. The deposits, replacements in dolomite, are conspicuous, being exposed as kopjes, or small hills, in the otherwise flat-lying country. The ore occurs as a central core of massive sulphides of zinc blende and galena, around which is an oxidized shell consisting of zinc silicates, iron oxides, quartz, zinc and lead carbonates, and vanadium minerals. Within the last four years the treatment of the oxidized zinc silicate ore has been possible by the erection of a specially designed electrolytic zinc plant with a daily capacity of about 55 tons of zinc, and a new hydro-electric power plant at Mulungushi Falls, about 35 miles distant, where 12,500 hp. is developed. The lead smelters, which produced over 115,000 tons of pig lead, have been closed down.

Early Portuguese traders knew of the presence of copper in the Belgian Congo and Northern Rhodisia. In 1899, the Kansanshi copper mine, about 230 miles northwest of Bwana M'Kubwa and about 150 miles northwest of N'Changa, was located by George Grey, who also explored the Katanga and located the large deposits now operated by Union Minière du Haut-Katanga. To him belongs much of the credit for the pioneer mineral exploration in this portion of Africa. The Kansanshi mine is at present being developed by the Rhodesia-Katanga company. Here the copper ore occurs in lode formations cutting through the schist beds and carries gold and silver. The schist beds in the mine area are pyritic, and in places contain sufficient copper to form important orebodies.

Bwana M'Kubwa mine was located by W. C. Collier in 1902. About the same time he located what is now known as the Roan Antelope mine. When the Bwana M'Kubwa mine was discovered, the richest part of the deposit was pitted with ancient excavations. The mine was worked intermittently until 1922, when it was taken over by Bwana M'Kubwa Copper Mining. The ore contains an average of 3 to 4 per cent copper, and the treatment plant is designed for 1,000 tons per day. It was closed in February, 1931.

World-wide interest in Northern Rhodesia has been focussed for the last few years on the discovery, exploration, and development of the extensive copper deposits, mainly in the N'Kana Concession, bordering the Belgian Congo. For the most part the deposits are huge synclinal occurrences in the sediments, extending for many miles in the direction of the axis of the syncline. In many formations both limbs of the syncline contain commercial ore. Unlike the oxidized deposits of the Belgian Congo and Bwana M'Kubwa, where the large orebodies of copper carbonate and silicate ores stand out prominently as kopjes above the surrounding country, little evidence of rich mineralization is to be found on the surface, as the country is level and covered with a soil blanket with but few outcrops. Lack of vegetation on the outcrops led to the discovery of several of the deposits. However, only by working out the geology in detail, and thus supplementing the data obtained from the outcrops, were locations for drilling exploration determined and the deposits proved up to their present dimensions. Five of these deposits are in course of development: Roan Antelope, and its westerly extensions known as Muliashi and Baluba; N'Kana; Chambishi; Mufulira; and N'Changa, with its westerly extension.

Actual ore blocked out by underground development is small, compared to the estimated tonnage calculated from drilling results. The latest estimates place this calculated tonnage at about 500,000,000 tons of 4 per cent copper ore, an enormous reserve of copper. These figures of estimated tonnage will probably be exceeded, but the amount of copper to be produced is a matter of individual opinion. It depends on financial arrangements for developing the mines and bringing them into production, the price at which copper can be produced, and the world's capacity to consume copper.

Generally speaking, complete oxidation has penetrated to the ground water level from zero to 200 ft. Below this the amount of oxidation varies from as little as at the Roan Antelope, N'Kana, and Mufulira, to almost complete oxidation as at N'Changa. The depth to which it occurs varies not only at the different mines but in the same orebody. The oxidized minerals are malachite, azurite, chrysocolla, cuprite, and tenorite.

Sulphide ore minerals are chalcocite, bornite, chalcopyrite, covellite, linnæite, and occasionally a little pyrite. Rarely, some native copper is found. The minerals occur as minute specks uniformly disseminated through the ore-bed rock of silicified sandstones and shales. Average grain size is about 0.5 mm., but many grains are discernible only under the microscope. Because of the presence of the cobalt mineral, linnæite or carrollite, the sulphide ores carry 0.02 to 0.46 per cent cobalt. This mineral is closely associated with the chalcopyrite. The amount of chalcopyrite is said to increase with depth. The specific gravity of the ore is 2.8, which is only a little higher than that of the barren rock.

All mining operations will probably be underground. Roan Antelope is the closest to production. The eastern section, consisting of the nose of the syncline and both limbs for about 4,000 ft., will be first mined. Several levels have been opened up from four incline shafts, two on each limb, and the main hoisting shaft has been put down in the footwall of the south limb. The concentrator is designed to treat 5,000 short tons of ore daily, provision being made for increased tonnage later. The ore, hoisted in 10-ton skips, will be crushed in McCully gyratory and Symons cone crushers, ground in two stages by Marcy ball mills provided with ample Dorr bowl-classifier capacity, and concentrated by flotation. The concentrate will be thickened, filtered, part dried, smelted without preliminary roasting in a standard reverberatory furnace, and the matte converted into blister copper. Pilot-mill test conducted on 3.5 per cent copper ore from development showed a concentration ratio of 15.5 to 1, a recovery well over 90 per cent in a concentrate averaging from 50 to 65 per cent copper. Very fine grinding is necessary, the ore having to be reduced almost to all through 200 mesh to liberate the mineral sulphides.

At the N'Kana mine, considerable de-

velopment has been done on the North orebody, to be opened up through four inclined and two vertical shafts, one of which will be the main hoisting shaft. The Mindola orebody will be opened up by several inclined shafts spaced at convenient intervals along the outcrop. N'Kana will be equipped for a daily capacity of 7,000 short tons of ore. Crushing will be done in gyratory and cone crushers, followed by rolls in circuit with screens. The concentrator and smelting equipment will be similar to those at Roan Antelope. A 300-ton pilot mill has been in operation working out the details of the concentration practice, the concentrate from which will be smelted at the Bwana M'Kubwa plant. The Bwana M'Kubwa leaching plant will be used for the treatment of the oxidized ore.

At Mufulira, the richest sulphide mine of the copper belt, development is in progress. The pilot mill at Roan Antelope is being used to evolve details for the concentration plant. A mill of 1,500 tons' daily capacity is being built. The concentrate will be treated at the Roan Antelope smelter.

At the N'Changa and N'Changa Extension mines, some development has been done on the North lode, where levels have been run from the shaft at 150 and 300 ft. On the Dambo lode, two inclined shafts have followed the ore down for 600 ft., at which depth a level was driven. The ore is mostly oxidized, and the method of treatment has yet to be established.

Roan Antelope, N'Kana, and Mufulira have established rail connections with the main line. Progress is such that Roan will be brought into production this year and N'Kana and Mufulira by 1932. An annual production of 150,000 tons of copper could be attained by 1933 from these three mines and increased to twice this amount in a further few years if conditions warrant.

At present, the chief rail outlet is southward to Bulawayo, in Southern Rhodesia, and thence to Beira, on the east coast, or southward to South African ports. The railroad from Lobito Bay, on the west coast, to connect with the main line north of Elisabethville, in the Belgian Congo, has been completed and gives a more direct outlet to Europe and America. Lobito is about 3,000 miles closer to European copper markets than Beira, the rail haulage from the mines being about the same distance.

Many problems must be solved to bring the mines to production, none of which are insurmountable, and all are gradually being mastered. The system of mine development and stoping to be employed requires careful study. With the ore beds dipping at various angles, no one system will apply to all the mines or to the various sections in the same mine. The drainage water of these great synclinal basins during the rainy season has to be controlled. Especially is this a problem in the heavy wet ground of the N'Changa mine. The mines with their concentrators and smelters will require a large power supply. Up to the present this is generated from coal from the Wankie collieries, in Southern Rhodesia, about 600 miles distant. A closer and cheaper source of coal is being investigated, as is also the development of hydro-electric power.

In every mining field of the world, the supply of trained white labor for the development and operation of mines and for the construction and operation of metallurgical works has not been a serious problem. Men have gone from Europe and America to all parts of the globe. They came to the diamond fields of Kimberley, to the gold mines of the Witwatersrand, and to the other mining districts of the Union and Southern Rhodesia, and carried on mining and metallurgical operations, just as efficiently and progressively as in Europe and America. And so to the mines of Northern Rhodesia, experienced operators and skilled workmen will be drawn to the great copper fields, as they were to the Rhodesian Broken Hill mines and the mines of the Belgian Congo, where conditions are similar.

The supply of unskilled labor is a more difficult problem. In fact, the existence of the mineral industry in Africa depends largely on the native, who, under the direction of the whites, performs all the unskilled work and to some extent the skilled work. In the Union, native labor for the mines is to a large extent imported from Portuguese East Africa. The natives of the Union and the Rhodesias do not take to mining, preferring agriculture and surface employment or living on their reserves.

To assure the mines of the Union of a supply of unskilled labor the necessity arose to form native recruiting agencies or labor associations. These recruit and bring the natives to established depots, distribute them to the mines, look after their health, and return them to their kraals after the term of contract has expired. Some such organization will have to be formed for a steady supply of native labor for the copper mines of Northern Rhodesia. In the Union about 340,000 natives are employed in the mining industry. In the Rand mines alone, about 210,000. The white force is about 22,000. Assuming that the same proportion is maintained, a force of 65,000 natives and 6,500 whites will be required to operate the Rhodesian copper mines for an annual production of 300,000 tons of copper.

The ball mill bay at the Roan Antelope mill, now in operation

In the mines of the Union, the average wage of the white employee is $5 per shift; for the native, 50 to 60c. per shift. The mines have, therefore, the advantage of cheap native labor, although this labor complicates the social problems of the country. One must admit that the low cost of mining is largely attained by the cheap native labor. A comparison of figures shows that one white man receiving $5 per shift in a Canadian mine produces as much ore as five natives receiving a maximum of 60c. a shift in a Rand mine. Whether or not white labor could produce very much more per man-shift than the natives, if working in the hot humid atmosphere that prevails in the deep levels of the Rand may well be questioned. Were it not for this cheap labor, much of the Rand and other reefs would not be profitable. Widths of 18 in. to 2 ft. are being mined on the Rand, at Pilgrims Rest and Sabie, in the eastern Transvaal, at the platinum-bearing Merensky reef, at the chrome beds, and other similar narrow-mineral occurrences. On the Rand, the great depths to which mining operations are carried are largely to be credited to native labor, with which it will be possible to go to even greater depths.

Personal Notes ..... Comment .... Criticism

W. W. Lynch and **W. F. Ferris** have severed their connection with the United Verde Copper Company, in New York.

John G. Barry, consulting mining geologist and engineer, of El Paso, Tex., delivered the commencement address at the recent exercises at the College of Mines, University of Texas.

Prof. L. C. Graton, of the division of geology, Harvard University, will spend the summer in Ontario investigating the geology of the ore deposits at the Hollinger mine and the mines of the International Nickel Company.

O. N. Friendly, mining engineer for Park Utah Consolidated, has been elected treasurer of the company, succeeding **D. C. Murphy. J. W. Stoner,** geologist and mine superintendent, succeeds **W. A. Dunn** as secretary.

Robert Tally, president of the A.I.M.E., will deliver an address at the dedication of the new engineering building at the Michigan College of Mining and Technology, which will take place at the alumni reunion, Aug. 6-8.

Morris J. Elsing concludes, in this issue, the series of articles on mining methods. In the near future will commence a second series, on a subject to which he has given close attention in recent years—the cost of mining in the United States.

Prof. Donald McLaughlin, of the division of geology, Harvard University, will continue his geological work for Homestake Mining during the coming summer. He expects to make mine investigations in Canada and California.

Allen H. Englehardt has been appointed mining engineer with South American Development, at Guayaquil, Ecuador. He graduated this spring from the Montana School of Mines, and was chosen by the Montana Society of Engineers as the outstanding member of his class.

Lawrence B. Wright has resigned as chief geologist of Homestake Mining to engage in general consulting practice. He is now directing the development of Double Rainbow Mines, a company that is exploring beyond the old faces of the Richmond-Sitting Bull property, at Galena, S. D.

Dr. Dorsey A. Lyon, supervising engineer of the intermountain station of the United States Bureau of Mines at the University of Utah, has resigned from the Bureau, and will devote his entire time to his duties as director of the Utah Engineering Experiment Station of the University.

Prof. Theodore Simons, professor of mining engineering at the Montana School of Mines, was the recipient of many expressions of congratulation and honor at the recent commencement exercises of the school, which were coincident with the completion, by Professor Simons, of 25 years on the faculty staff.

Dr. M. N. Short, author of the U. S. Geological Survey Bulletin No. 825, recently issued, entitled "Microscopic Determination of the Ore Minerals," and of other publications, has been appointed

professor of optical mineralogy at the College of Mines and Engineering of the University of Arizona. He will take up his new duties next September.

F. C. Bond, who contributes the article in this issue on particle size calculation, has served on the faculty of the Colorado School of Mines, from which he was graduated in 1922, and contributed many articles to this publication prior to and during field work with the New York & Honduras, Tennessee Copper, and other companies. He is now a member of the staff of the mining research laboratory of the Allis-Chalmers Company, Milwaukee, Wis.

Robert Sibley, director of the California Alumni Association, claims, in "America's Answer to the Russian Challenge," published recently, that the success of the Russian effort depends chiefly on the acquisition of cheap power. Accepting Lenin's definition of sovietism as "Communism plus electrification," Mr. Sibley compares Russia's electric power strength, if the five-year plan is successful, with what the United States has already accomplished. "She will find herself," he says, "a nation possibly still calling herself Soviet Russia, but to all intents and purposes American to the core in education, in ideals of home, and, above all, in the burning desire to press forward under the undying urge of the highest type of individual initiative."

Dr. W. S. Ayres, of Hazelton, Pa., 30 years ago, after an examination as a consulting mining engineer, estimated, in an official report, that the iron-ore deposits of the Dominion Iron & Steel Company, in Concepcion Bay, Newfoundland, extended 6 miles across the bay. Now, after nearly 30 years of mining at the rate of 6,000 tons per day, the workings are reported to be nearly three miles out under the ocean, with three of the six miles yet to be exploited. The bed of iron ore has continued practically unchanged. **Dr. Scott Turner,** director of the United States Bureau of Mines, who visited the property in 1930, believes the deposit to be continuing without change as to direction, thickness, and quality of ore. Mr. Ayres has been a member of the A.I.M.E. for nearly 58 years, and was the guest of honor at a dinner of the Institute, held this spring in Wilkes-Barre, Pa., on the occasion of the 60th anniversary of its founding.

Analysis of Electrolytic Zinc

To the Editor of "E.&M.J.":

Having had to perform recently just the type of analyses described in the article by B. H. Strom in a recent issue on the analysis of high-grade electrolytic zinc, we read his contribution with considerable interest. We wish here to offer our criticism of two of the determinations which he describes.

The analysis of this grade of zinc, which is sold on the basis of 99.99 per cent purity, presents extraordinary difficulties to the chemist. The ten-one-thousandths per cent of allowable impurities is usually divided among four metals, namely, copper, cadmium, lead, and iron. On the basis of 100 grams of original sample, which is about as large as can be handled conveniently in routine work, this means ten milligrams to be divided among the above four metals. If the analysis is to have any significance, these metals must be determined with considerable accuracy, say about 10 per cent error. It is plain that the methods of collection can permit of no loss, and that the methods of measurement must be precise.

The determinations with which we find fault are those for lead (by the chemical method) and iron. Let us examine the lead method first. Mr. Strom precipitates the Pb, after a preliminary concentration, as $PbSO_4$ in a dilute H_2SO_4 solution and makes the final measurement by titration with molybdate. It is well known that $PbSO_4$ has a slight solubility, even in dilute sulphuric, although in ordinary analyses, in which comparatively large amounts of Pb are involved, this loss may be of no importance. Seidell ("Solubilities," Vol. II, 1928, page 1267) says this on the subject: "A saturated solution of $PbSO_4$ in aqueous sulphuric acid of concentration between 0.1 and 20 per cent H_2SO_4 contains between 0.0071 and 0.0105 gram $PbSO_4$ per liter at 30 deg. (Dawkins and Weldon, 1922, 1925)." In addition, the zinc (or iron by the alternate method given) certain to be present also exerts a solvent action on the precipitate. In fact, in our cell electrolytes, containing both zinc and free acid, we have found as much as 15 milligrams of dissolved Pb per liter. Mr. Strom's method deals with never more than about 3 milligrams. This precipitation as the sulphate therefore must entail some loss.

The measurement of the isolated Pb is by titration with molybdate. But authorities are agreed that for small amounts of Pb the molybdate titration is unsuitable, the recommended method being precipitation of the Pb as the chromate and subsequent titration of the iodine liberated by the reaction with KI. So here, too, error may creep in.

We had so much trouble with the Pb determination, using standard methods, that finally one of our colleagues, Dexter H. Reynolds, worked out an entirely new method, involving the precipitation of the Pb with NH_4OH, using aluminum as a collector, and making the final measurement nephelometrically on a colloidal lead molybdate precipitate. We hope soon to publish this method.

As to the iron determination, the thiocyanate-colorimetric method was thoroughly investigated 25 years ago by Stokes and Cain (*J. Amer. Chem. Soc.* 29 (1907), 409 and 443.) See discussion in Yoe, Photometric Chemical Analysis (1928), page 218. They found that so many substances affected the red color that the only safe procedure for accurate results was to make the colorimetric comparison in an ether-amyl-alcohol solution. We tried the thiocyanate method as described by Mr. Strom but were not successful with it, finally

changing to the salicylic acid method as given in Yoe, page 243, which proved to be quite satisfactory.

Our difficulties with chemical methods, and the fact that they were so slow, led us to develop spectographic methods for the determination of lead and cadmium. These proved to be nearly as accurate as the chemical procedures for the small amounts involved, and, in addition, were very much more rapid. For instance, a combined Pb and Cd determination required only about 45 minutes after the metal was in solution. Moreover, when errors did occur, they were never as gross as with the chemical methods.

MORRIS SLAVIN,
WILLIAM O. HAMILTON, JR.
Clarkdale, Ariz. United Verde Copper.

Ball Milling and Amalgamation in Lower California

To the Editor of "E.&M.J.":

This mine, a free milling quartz fissure vein 12 miles southeast of Todos Santos, was worked about 18 years ago to a depth of 200 ft., and produced about $150,000. Ore was treated by a small stamp mill prior to abandonment and until the present company, two years ago, cleaned out the old workings and put the property into shape for developing. A vertical shaft is being sunk to cut the vein 100 ft. below the old workings. The vein averages 1 to 4 ft wide.

The new plant consists of a 30-ton screen-type Rib Cone ball mill, of simple design and easy to run. The ore, $20 per ton, is crushed to ½ in., then delivered to the mill, which is equipped with a 20-mesh screen, which gives a 30-mesh product. Some of the ore is exceptionally hard, but the mill averages 1 ton per hour. After milling about 800 tons I can see no appreciable wear on liners, and the original screen is in use. No further milling will be done, however, until the new shaft is down and the vein is cut.

I believe in getting the gold as soon as possible after the pulp leaves the mill. A cement launder between mill and plates is equipped with riffles and quicksilver, which recovers 75 per cent of the gold. The total recovery is 85 per cent, which is similar to what I obtained on this ore by stamp mill 18 years ago. My mill force consists of two men (Mexicans) per 8-hour shift.

G. W. PICKETT.
Todos Santos, Baja California, Mexico.

Natural Gas in Colorado

To the Editor of "E.&M.J.":

The following will supplement information given in the article by A. H. Hubbell on "Natural Gas" in the May 25 issue:

So far as I am aware, natural gas is not used in any mines in Colorado. The Colorado Fuel & Iron Company is using it in its smelters, rolling mills, and other operations in Pueblo. The brick plants of that town are also reported to be using it, as well as those at Golden and the Coors porcelain plant and a small pottery at the same place; likewise, several brick yards at Denver. Gas, brought in from Texas by the Colorado Interstate Gas Line Company, is distributed to various users, including the Public Service Company of Colorado, with headquarters in Denver and branch offices in several towns. The pipe line enters the state near Trinidad and is tributary to Walsenburg, Pueblo, Colorado Springs and several smaller towns between Colorado Springs and Denver. A new line is being carried across to Brighton, but it will not serve mines or smelters.

The cement plant at Boettcher is using natural gas, the supply coming from the Colorado-Wyoming Gas Company's line, which runs from Denver to Cheyenne by way of Boulder and Loveland. A line from the Berthoud field carries gas to the Colorado-Wyoming company's line, serving the Loveland brick plants. A line from the Wellington-Fort Collins field formerly supplied the Boettcher plant, but at present the Continental Oil Company controls the oil and is unwilling to supply as much gas as the plant requires. For this reason, it has been hooked up with the Colorado-Wyoming company's through line from Denver to Cheyenne.

A large quantity of natural gas containing widely different percentages of carbon dioxide is available in northwestern Colorado, mainly north of the Colorado River, but as there are neither mines nor smelters in that part of the state the gas is now shut in, with little prospect of its utilization in the near future.

Natural gas has also been found in southwestern Colorado, but in comparatively small quantity, and nothing has been done to use it industrially.

The gas distributed by the Colorado Interstate Company from the Amarillo field has a fuel value of 825 B.t.u. That from the Wellington and Berthoud fields plays but a minor role, but has a fuel value of approximately 925 B.t.u. per cubic foot.

R. D. GEORGE,
Colorado Geological Survey.
Boulder, Colo.

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Obituary

R. W. Rusterholz, Ingersoll-Rand representative at Johannesburg since 1919, died there on June 17. He was born in Peoria, Ill., 54 years ago.

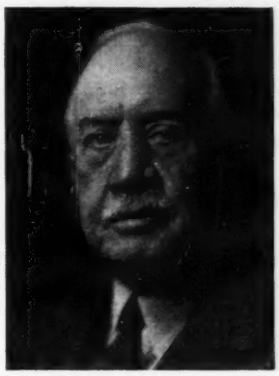
C. G. Smith died recently at his home in Fullerton, Calif., after a long illness. He was known to his many friends in Mexico and Nicaragua as Cyanide Smith. He was 53 years old.

William Forstner, mining engineer, of San Francisco, died on June 15, as the result of an accident. He had been retired for some years, but had maintained an interest in quicksilver mining.

Mrs. John Hays Hammond died on June 17 at her home in Washington, D. C., after a brief illness. She had many friends in the various mining camps in which she had lived earlier in her husband's career.

James Henry Devereux, pioneer mine operator in Colorado, died on June 13 at a hospital near his home in Northampton, Mass. He was 74 years of age, and had also been interested in later years in hydro-electric developments.

W. L. Saunders, chairman of the board of directors of the Ingersoll-Rand company, and inventor of several devices for rock drills, died on June 25, at Teneriffe, Canary Islands. Mr. Saunders was president of the A.I.M.E. in 1916. He founded the award for achievement in mining, presented each year by the Institute, which bears his name. He was born in Georgia in 1856, and graduated from the University of Pennsyl-



vania in 1876. In 1881, after varied experiences, he became engineer for the Ingersoll Rock Drill Company, stayed in the employ of this company, and subsequently became president and then chairman of the board of the successor company. Mr. Saunders was also very active politically, and served the government ably during the War. He is survived by two daughters.

Frost L. Benham, who, prior to his recent appointment as manager of the United Verde Public Utilities Company, Jerome, Ariz., had been chief clerk for United Verde Copper, died in Jerome on June 16, as the result of injuries sustained in an automobile accident.

Otto Mears, prominent figure in the opening up of the West and Southwest, died in Pasadena, Calif., on June 25, at the age of 91. He built many miles of roads and railroads in the Southwest, and was active at one time in mining in Colorado.

Harrison E. Clement, general manager of Abana Mines, Ltd., at Dupuy, Que., died on June 24, in Toronto, of heart disease. He was born and educated in New Hampshire, worked first in Idaho, and lived for fourteen years in Salt Lake City. Mr. Clement, who was 46 years old, had lived in Canada since 1923.

Kirby Thomas, consulting mining engineer, died on June 23, at Amos, in northern Quebec. He was at the time of his death vice-president of Golden Chariot-War Eagle Mines. Mr. Thomas was born in Wisconsin, and graduated from the State University. He was an engineer for 32 years, and during that time made investigations and reports on many properties in the West and Mexico. He was for a short time an associate editor of *Engineering and Mining Journal,* and, later, editor of the *Mexican Mining Journal.* Mr. Thomas was 62 years of age, and is survived by his wife, two brothers, and a sister.

INDUSTRIAL PROGRESS

Calumet & Hecla Has Modern Power Plant in Service at Ahmeek Mill

A new power plant to furnish steam for the Ahmeek mill, Hubbell, Mich., and to supply additional power for mines that needed it, was completed some time ago by Stone & Webster for Calumet & Hecla Consolidated and is now in commission. Half of the steam capacity is intended for mill purposes, the old steam plant being thus replaced, and the balance for generating electric power that will be turned into Calumet & Hecla's general distribution system, as an additional supply. The old hand-fired plant is still standing. The company's engineers, realizing that additional power was needed, concluded that it would be cheaper to make the steam with modern up-to-date equipment than to enlarge the existing plant.

Steam-making equipment comprises three Babcock & Wilcox Stirling-type boilers having 897 hp. Each boiler has three Fuller-Lehigh water walls and a Westinghouse link-grate stoker. Fuel used is coal of 14,000-plus B.t.u. quality, crushed in a toothed-roll crusher to $1\frac{1}{4}$ in. maximum size. From the bins the coal goes by Link-Belt flight-conveyor to the crusher, thence by another conveyor to the bunker. Steam is made at approximately 425 lb. pressure and 680-690 deg. (temperature) of superheat. Draft is supplied by a motor-driven induced-draft fan and a Terry forced-draft fan. Combustion is controlled by a Hagan automatic, also by a Westinghouse device on the Hagan induced draft that feeds more coal when the steam pressure falls off. Water is fed to the boilers by Cameron turbine-driven pumps capable of working at 1,316-ft. head. A differential of 40-50 lb. above steam pressure is maintained by a Fisher governor to force the water through the economizer. The water is conditioned by the Hall Laboratories system.

Inasmuch as the steam-driven machinery in the Ahmeek mill is working at only 160 lb., the pressure of the steam produced by the new plant must be reduced to that level from 425 lb. Likewise the temperature (680-690 deg. F.) of the superheated steam must be reduced to that of saturated steam at 160 lb., because the reciprocating steam-driven machinery in the mill will not stand the higher temperature. To effect this reduction as economically as possible the steam is first passed through a Terry 1,250-kw. turbine, working on a back-pressure governor set at 160 lb. The steam, after leaving the turbine, still has considerable superheat and this is removed by passing the steam into a desuperheater of the accumulator type. This supplies saturated steam at 160 lb. The combination of turbine and desuperheater provides the required pressure without superheat for mill purposes. Should anything happen to this turbine, steam for the mill can be supplied through two by-pass reducing valves.

A feature of the new plant is its comparatively ample space. The mill steam, sent to the Terry turbine, is taken off at one end of the building. The remaining half of the steam, which is to supply the additional power, is taken off at the other end and goes to a 7,500-kw. Allis-Chalmers turbo-generator housed in a separate building. This is a 9,375-kw. unit, giving 7,500 kw. at 80 per cent power factor. It operates at 13,800 volts, 3 phase, 25 cycles, and 1,500 r.p.m.

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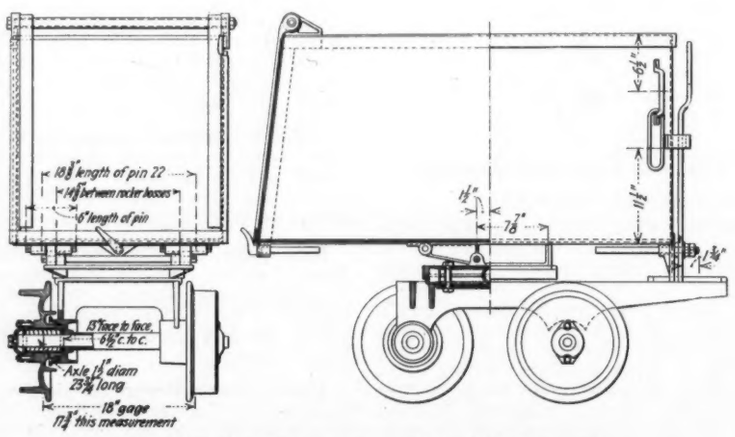
New All-Steel Mine Car Simple in Design

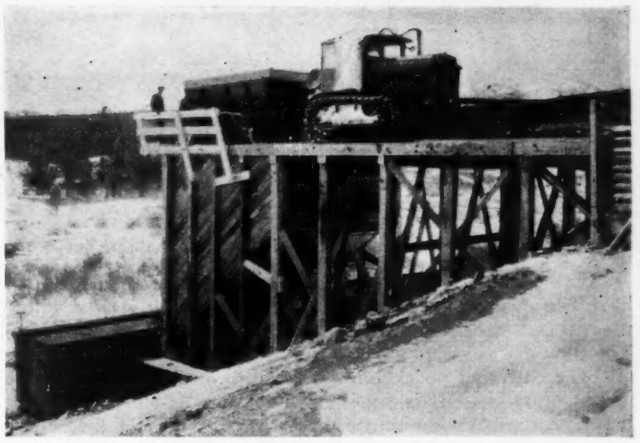
Other New Equipment

Careful selection of haulage equipment—in particular mine cars—is a prerequisite to successful ore transportation and low operating costs. Subjected to severe service, a minimum of care, and bad treatment in general, the poorly built car suffers in consequence. Likewise, the type of car must be suited to average conditions, with respect to dumping and transfer to the surface, if further loss of efficiency is to be avoided. Another important item to consider when selecting mine cars is the question of maintenance. Simplicity in design and sturdy build mean low repair costs. A new type of mine car, designed to meet the severest tests, is the all-steel 18-in. gage unit recently developed by the Greene Manufacturing Company, of Berkeley, Calif., shown in detail in the accompanying cuts. The unique feature embodied in its construction is the unit steel casting comprising the car chassis. This casting is so designed that it can be made entirely in "green sand," or without the use of cores, and is therefore well adapted for production molding. The upper part of the chassis provides the lower raceway for the roller-bearing turntable, and a simple steel casting constitutes the upper raceway, including the plate on which the rocker hinges rest. The carefully welded-on labyrinth hub housings in-



This all-steel mine car has unit cast-steel chassis

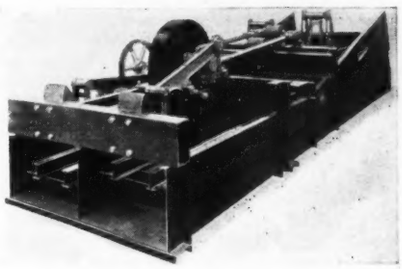
sure permanent wheel alignment, with consequent avoidance of hard running and undue wearing of the wheel. Additional stability of the chassis is afforded by the pipe spacers, welded onto each hub housing end, which also serve as axle housings. All wheels are fitted with No. 18280 Hyatt roller bearings. Being made of cast steel, the wheel flanges and treads, when worn, can be rectified in a lathe, at low cost, and the life of the wheel thus prolonged. The car body is arc-welded. Sides and doors are made of $\frac{1}{8}$-in. sheet steel; bottoms of $\frac{1}{4}$-in. plate; and $\frac{3}{8}$x1$\frac{1}{2}$-in. strap iron is used for reinforcement. Bolted-on wheel caps and small etched-brass nameplates, sealing off the space between the wheel and the hollow labyrinth hub housing, protect the bearings from dirt and water. Door hinges and all parts of the locking mechanism are of all-steel construction. The $\frac{1}{8}$-in. "Zerk" fittings attached to the wheel caps facilitate the proper oiling and greasing of the car wheels.



Caterpillar tractor (Model Sixty) owned by Gately Motor Company, Alma, Colo., with La Plante Choate crawler wagon, hauling gold ore 8 miles to railroad. Altitude 12,000 ft. Steepest grade 35 per cent. Average load 15 tons twice a day.

Mechanical Classifier Improved

THE Dorr F classifier is announced by The Dorr Company. Improvements in design and the use of a new type of head motion permit the use of higher speeds than formerly possible, accompanied by a corresponding increase in sand-raking and overflow capacities. The classifier was developed and perfected to meet (1) the tendency toward the maintenance of larger circulating sand loads in closed-circuit grinding, and (2) the trend toward coarser separations at the primary-classification stage in multiple-stage fine grinding. The machine operates at speeds 50 per cent greater than the maximum possible previously. Working parts are of cast steel, with pressure-lubricated bearings of the ball or roller type. Heavy welded construction is used throughout on the steel-tank and reciprocating-rake assemblies.



Improvements in this classifier include new type head motion

A reduction has been effected in the head room required, giving the classifier a pronounced underslung, compact appearance. Simplification of design has reduced moving parts 22½ per cent, regularly lubricated parts 33 per cent, and infrequently lubricated parts 50 per cent. Prior to its introduction on the market, one machine was operated for a year at the property of the Nevada Consolidated Copper Company, at McGill, Nev. Twenty-one machines are in use or on order for the copper, gold, cement, coal, and sand and gravel industries.

The Dorr F classifier is offered with and without the bowl, for all separations from 10 to 325 mesh. Widths range from 3 to 16 ft.; lengths vary according to specifications of grinding mills with which the classifiers are to operate in closed circuit; raking mechanisms are furnished in the simplex, duplex, and quadruplex types.

Centrifugal Pump Non-Clogging

A non-clogging centrifugal pump intended primarly for handling sewage, and having wide application aside from this, has been introduced by the Morris Machine Works, Baldwinsville, N. Y. In one instance, a wooden ball 8 in. in diameter passed through a 10-in. pump. The test curves of a typical pump show an efficiency of more than 80 per cent when working over a range of 67 to 120 per cent of normal capacity. These pumps are built for both horizontal and vertical shaft installations in sizes ranging from 3 in. to 42 in. and for any type of drive.

A Simple Reagent Feeder

What is known as the Adams reagent feeder has recently been announced by Mine & Smelter Supply Company, Denver. This device is operated by an adjustably controlled siphon system. It has no motor or driving mechanism, so no operating expense is entailed. The feeder handles chemical collectors at a minimum rate of one drop in 19 sec. to a maximum of 247 cu.cm. in 5 sec. Frothing oils may be fed at a minimum of one drop in 65 sec. to 288 cu.cm. in 45 sec.

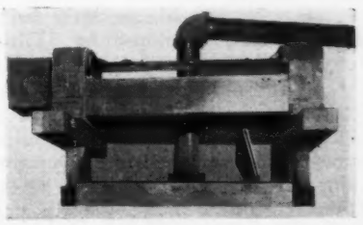
Electric Sampler Is Automatic

A new automatic sampler has been placed upon the market by the General Engineering Company, Inc., of Salt Lake City. It is electrically operated and is designed to conform to the requirements of cutting the entire stream flow part of the time and the removal of equal percentages from all parts of the stream at equal and adjustable time periods. The cutter itself hangs from the inclosed cutter carriage unit which consists of a motor, a speed-reduction unit, and a reversing switch within a dustproof cast-iron case. The carriage is mounted upon flanged wheels and rails and driven by a pinion engaging an inverted rack. Cone-shaped helical springs limit the travel of the carriage. A steel arm projects through a slot in the carriage cover, from the reversing switch, and is operated by lugs fastened to the sampler case. Limit switches are placed at each end of the sampler case to break the circuit when the carriage has completed its travel. The timing device, driven by a Telechron motor, starts the cutter carriage unit at predetermined time intervals, 5, 10, 15, 20, 30, and 60 minutes. A series of toothed wheels, timing wheels, enable the time interval to be adjusted. The timing wheel operates a mercury switch. The general appearance of the sampler is shown in the accompanying illustration.

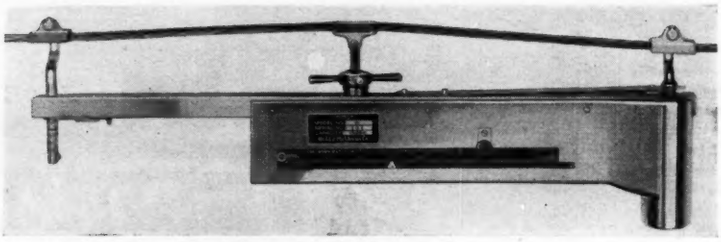
New Developments in Rubber

A new rubber matting for use as a safety insulator at power switchboards has been developed by the Diamond Rubber Company, Akron, Ohio. This matting, which is $\frac{1}{4}$ in. thick, is guaranteed to withstand 15,000 volts under the voltage test and 40,000 volts under the dielectric test, prescribed by the American Society for Testing Materials. It has six laminations of high-grade rubber and a ply of fabric to give additional strength.

A new dressing for rubber belts has also been introduced by this company. Hitherto manufacturers of rubber belts



Electric sampler, cover removed



This tensiometer is intended for determining tension on wires, cables or other lines quickly and accurately

have been obliged to advise against the use of belt dressings with their belts. The new dressing is said to contain no oil or grease and no chemicals harmful to belt or pulley. It is not inflammable, it retains its tackiness longer than many other dressings, and doubles the pulling power of the belt. It comes in stick form.

Insulator for Furnaces

A new insulating firebrick, known as the B.&W. No. 80, has been announced by Babcock & Wilcox Company. Previously this material has been made experimentally, but until recently there has been no practical method of manufacturing it. The company is now producing it on a commercial scale. It is said to be not only an insulator, but the equal of first quality firebrick. It may be used without a facing of firebrick on the furnace side, exposed to furnace temperatures and gases, and protected only by a coating of high temperature or packing cement. The brick is suitable for lining oil- and gas-fired furnaces, electric-resistance furnaces, and for coal-fired equipment wherever it will not be exposed to mechanical abrasion and slag action. It is said to be easily handled and may be cut, drilled, or shaped with ordinary woodworking tools.

Some New Instruments

A new potentiometer-pyrometer in indicating, recording, multiple-recording, and controlling types has been developed by the Brown Instrument Company, Philadelphia, Pa. High accuracy, easily maintained throughout the life of the instrument, is claimed. Among its many features is the inclusion of a humidity compensator, which is built into the instrument, which automatically corrects the pen position and brings it into proper register with respect to the chart markings. The charts are also printed under a standard condition of humidity.

A hydrometer of simple and sturdy construction, having a body without ballast bulbs, glass seal ridges, necks, or knobs, this to facilitate cleaning and using it with less likelihood of breakage, has been developed by William Hiergesell & Sons, 295 Pearl St., New York. It is known as the "Herco Streamline" hydrometer. It has a tip, the interior of which has been metalized by deposition, the shell forms being the major part of the ballast. This metalization is said to make the tip practically unbreakable.

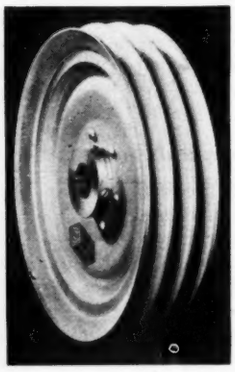
One of the illustrations shows the Hills-McCanna tensiometer, a device intended for giving the tension on wires, cables, and lines quickly and accurately. It is built for service in the field, having a case of heavy aluminum, all exposed parts being either chromium plated or of stainless steel. The instrument weighs 14 lb. and is 2½ ft. long over-all. The standard model will test all wires and ropes up to 1 in. in diameter, and has a tension capacity of 16,000 lb. Meters of larger capacity can be supplied. The instrument is unusually sensitive and will register the slightest change of tension while in place. This extreme accuracy also permits its use for weighing. Among its applications is said to be that of determining the stress on hoisting rope.

Rolled-steel Gear Blanks Welded

All-welded, rolled-steel gear blanks for use in making cut gears are being made by Lukenweld, Inc., Coatesville, Pa. The blank, which can be used to make spur, herringbone, and helical gears, can be any size from 24 in. outside diameter up. Usually such blanks are made entirely from S.A.E. 1020 carbon steel, but the rims, if desired, can be had in special steels.

Light Sheaves for V-Belt Drives

A new type of pressed-steel sheave for Texrope drives has been developed by Allis-Chalmers. This is known as the Texsteel sheave and is die-pressed from extremely tough steel, after which each section is welded both at the web and at the rim to eliminate all vibration and noise and to give an accurate balance for true running. The sheaves described are made in a large range of diameters, permitting ratios as high as 6 to 1. They are painted with aluminum paint.



A pressed-steel sheave for Texrope drives

A New Safety Hoist

A high-speed overhead hoist, made of aluminum alloy and having a patented overload governor to indicate and prevent dangerous overloading, has been announced by the Chisholm-Moore Hoist Corporation, Tonawanda, N. Y. The patented feature warns against hoisting with more than 50 per cent overload. The hoist is called the "Al-Lite," is at least a third lighter than ordinary hoists of the same capacity and yet as strong and dependable, and can be handled by one man. It has a bright red load hook, a proof-tested Inswell chain, adjustable load brake, grease bath lubrication, tilting top hook, ball bearings at most important points, and a dust-proof oil-tight housing.

Lubricating Open Gears

A home-made mixture for lubricating open gears can be made by mixing ½ lb. of white lead with ½ gal. of cylinder oil and ½ lb. flake graphite, according to the Link-Belt Company, which suggests this as a lubricant for cranes, excavating units, and other machinery. This mixture is said to adhere well to the gears and can be painted on with a brush at five-hour intervals. The graphite and oil form the lubricating content and the white lead acts as a binder and keeps the gears from cutting. Cup grease may be substituted for the oil. The graphite may be omitted, but it is not advisable to do so in warm weather. The mixture may be made heavier for warm weather by using less oil or grease in proportion to the graphite.

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Industrial Notes

The explosives manufacturing operations of the Emporium, Pa., plant of the Hercules Powder Company will be transferred to the company's largest plant at Kenvil, N. J., by Aug. 1. New economies and the more advantageous location of the Kenvil plant are said to be responsible for the change.

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Bulletins

Conveying. Diamond Rubber Company, Inc., Akron, Ohio. A 40-page pamphlet entitled "Belt Practice," dealing with conveyor and elevator belts.

Piping, Valves. Semet-Solvey Engineering Corporation, 40 Rector St., New York. Bulletin No. 44. Information given includes suggestions for efficient planning of new piping.

Blowers, Compressors. Ingersoll-Rand Company, New York. Bulletin entitled "Turbo-Blowers and Turbo-Compressors."

Speed Reducers. W. A. Jones Foundry & Machine Company, 4401 Roosevelt Road, Chicago. Bulletin 51. Herringbone-Maag speed reducers.

Elevating and Conveying. Fairfield Engineering Company, Marion, Ohio. A 100-page catalog.

Buildings. Butler Manufacturing Company, Kansas City, Mo., and Minneapolis, Minn. Catalog 112. Ready-made steel buildings.

NEWS OF THE INDUSTRY

Grass Valley and Mother Lode Activity Reflects Increased Interest in Gold

Not only are the established producing mines working at or near capacity, but several of the newer properties in the Grass Valley and Mother Lode areas of California are either building mills or increasing mill capacities. These two camps are the largest lode gold-producing centers in the State.

At Grass Valley, the three largest properties—Empire-Star, now a Newmont Mining subsidiary; Idaho-Maryland, and Murchie—are employing full crews and operating their mills to capacity. At the Empire mill, 80 stamps are in use and the North Star mill is also handling some ore. Idaho-Maryland is handling about 150 tons of ore daily in two mills and is experimenting with flotation.

At the Murchie, 150 men are employed and 140 tons of ore is being milled daily on two shifts. The stamp mill is being increased to twenty stamps, and the operators expect that 250 tons of ore per day will be treated. The stamp-mill product is ground in an Allis-Chalmers ball mill and sent to Kraut flotation cells, six roughers, and two cleaners. The rougher makes a tailing product, the froth going to the cleaner cells and the tailing returning to the rougher circuit. Extraction is about 96 per cent. A No. 5 gyratory has been installed in the crusher division, and limited provision has been made for hand sorting.

Hogue Development has about completed financing for mill construction. It has been shipping ore recently. Federal Consolidated Mining is employing 45 men and has remodeled the St. Louis mill, installing Kraut flotation units.

On the Mother Lode, Central Eureka has completed its drift between the 2,300 level of the Old Eureka and the 2,540 level of the Central shaft. Ore is being hauled underground by a Goodman storage-battery locomotive between the two shafts. About 130 men are employed and new ground is being rapidly developed. The O'Brien tailing plant, operating on Central Eureka tailing, has been put in operating condition, and initial difficulties are being overcome.

At the Kennedy Mining property, interest is being centered upon crosscutting on the lowest level (4,950 ft.). The vein will probably be intersected early this month. In the mill, 60 stamps are being operated. Flotation experiments are being brought to completion.

Argonaut Consolidated is sinking a winze below its 5,850 level to a depth of 300 ft. and is planning to open two new levels. A general improvement in ore conditions has been encountered. Recently the compressed-air pipe lines underground were rehabilitated. Better operating conditions have resulted. The mill is handling 250 tons per day, and 150 men are employed.

Amador Metals Reduction is treating Argonaut tailing and it also operates a custom plant for gold-mill concentrates. A recent installation at this plant consists of an American three-leaf filter, a Ruggles-Cole drier, and a sacker. The new equipment is used in the preparation of concentrate tailing for oil-well work. A Coe classifier is used to classify the concentrate tailing.

West of Jackson Russell-Kent Mining has installed a headframe, gasoline hoist, and shops, and is sinking a 300-ft. three-compartment shaft for exploration purposes. A Rix and an Ingersoll-Rand gasoline-driven portable compressor are used for compressed-air requirements. The new shaft is several miles west of the Mother Lode. Outcome of exploration work will be awaited with interest. The property is called the Pathfinder.

The first steps are being taken to reopen the Angels and Sultana properties at Angels Camp. A headframe is being constructed over the 850-ft. shaft of the Angels. The new company is known as Angels Consolidated Mines, and is controlled by Elmo Lincoln and Todd B. Elliott.

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U. S. Smelting Reopens Mines in Tintic District

Operation of the Eagle & Blue Bell and Victoria lead-silver mines, in the Tintic district of Utah, has been resumed by U. S. Smelting, Refining & Mining, which acquired the properties when it absorbed Bingham Mines in 1929. Some shaft and underground repairs will probably be necessary to put the mines in condition, as they have been closed for more than a year. Both units are worked through the Eagle & Blue Bell shaft, more than 2,000 ft. deep. Only one shaft will be used for the present, and work will probably center on development rather than production. Reports for Utah ore shipments in the week ended July 7 show one carload shipped from the Eagle & Blue Bell and another shipped from the Victoria in the preceding week.

At its Bingham properties, U. S. Smelting is maintaining its usual production. The average of recent weeks has been about 14 or 15 carloads of ore daily.

■

Curtail Japanese Copper Output

The Copper Manufacturers' Association in Japan has adopted a schedule for the second half of 1931 which provides a monthly output of 6,200 tons, divided among five Japanese companies, according to a report received in the U. S. Department of Commerce from Trade Commissioner William S. Dowd, Tokyo. The monthly allotment for exportation was placed at 2,500 tons for Europe and from 600 to 700 tons for Oriental countries. In 1930, the Japanese mines had an average monthly output of 7,300 short tons.

Nevada to Continue Operations at All Three Units

The report circulated recently that Nevada Consolidated Copper is to concentrate its operations at its Nevada mine and plant, in the Ely district, is without foundation. Ray, Chino, and Ely are being operated on a restricted output and will continue on this basis until the present situation is improved.

Progress is being made in the improvement of mining facilities at Ruth. Electric power shovels are to be installed gradually in place of the steam shovels. Orders have already been placed for two 120-B Bucyrus electric shovels, 4-cu.yd. dippers, full revolving, and these will be placed in operation as soon as received. All three properties are in splendid operating condition and capable of making low operating costs when capacities are increased.

■

Denver Interests Reopen American Nettie Mine

Development work is to be resumed in the lower levels of the old American Nettie mine, in the Ouray district of Colorado. A group of Denver interests, including F. G. Bonfils, publisher of the Denver *Post;* J. D. Warfield, Denver attorney; and E. A. Phinney, president of the Ruby National Bank, of Golden, have formed a new company, to be known as American Lease, Inc. William McCullough, who was superintendent for Mutual Gold Mines, which operated the property under lease, will be superintendent for the new company. Charles M. Bell will be general manager.

The American Nettie mine consists of fourteen claims. Gold occurs in vugs as a replacement in quartzite, about 20 ft. thick. The new development work will be undertaken in a lower quartzite zone, along a limestone contact, and will center on large low-grade sulphide orebodies. The property is developed by several tunnels, the newest of which is 1,800 ft. long and 700 ft. below the old workings. Equipment includes a small mill. Production since 1889 is estimated at $4,500,000 in gold.

Mutual Gold Mines operated the property under lease from 1925 until 1927, when a fire destroyed a tram terminal at the mine which connected it with a new mill on the Uncompahgre River.

■

Plan Mill for Vanderbilt Gold

H. G. Humes, who reopened the Vanderbilt gold property in eastern San Bernardino County, Calif., and who shipped fifteen cars of ore, is now exploring the veins on the property. He is planning the erection of a concentrating mill. Several oreshoots have been opened up. A two-drill compressor and 25-hp. gasoline hoist is the present equipment. T. S. Hardester is superintendent.

U.V.X. Strikes Ore in Haynes Claim; Extent Unknown

High-grade copper ore, of unknown extent, has been developed in the Haynes claim of United Verde Extension, in the Jerome district of Arizona. Should continued work yield favorable results, the strike will be of great importance to the company, as the original orebodies in the mine are nearly exhausted. Not more than three years of additional life is assured for the company with its present reserves, based on normal production of 25,000 tons of copper anually. In fact, United Verde Extension has been active in outside camps, notably gold, in an effort to prolong the life of its company.

The Haynes group, in which the new ore was found, is about 4,000 to 4,500 ft. from the company's main workings at Jerome. It was acquired several years ago, but, because of the distance from the main workings, the development has been undertaken by United Verde Copper on U.V.X.'s behalf. Ore was struck at a distance of about 150 ft. from the United Verde Copper line and at a depth of 3,000 ft. The mineralization was bunchy where it was first struck, but with the drift turned north, it soon entered a stronger formation. This drift has been driven about 60 ft. and for a considerable distance has had a full width of copper ore in it averaging 7 per cent copper and $1 a ton in gold.

No raising or crosscutting has been done, and so nothing definite can as yet be said in regard to the new ore zone as to size. However, with the drift now showing ore across its full width, or, say 4½ to 5 ft., and from top to bottom of drift, or, say, for a vertical height of 7 ft., the development is quite encouraging.

■

Montana "Vigilantes" Meet

The Vigilante Mining Association held its second meeting at Three Forks, Mont., on July 3 and 4. The meeting was presided over by Ben. H. Jackson, head of the organization. At the first day's meeting, three guest speakers were on the program. J. D. McKenzie, manager of the East Helena plant of American Smelting & Refining, and L. R. Margetts, manager of the Washoe sampler of Anaconda Copper, spoke on ore smelting rates. Carl J. Thauerman, mining engineer and president of the Montana Stock & Bond Company, Butte, spoke on "The Immediate Necessity of Advertising Montana's Gold Mining Possibilities." The second day's meeting was restricted to members of the organization. Operating economies were discussed.

■

New Boss Tweed Operators

Boss Tweed Clipper Gold Mines, Inc., has been incorporated in South Dakota by L. O. Goodman and R. H. Sawyer, of Butte; C. E. Morris, Pony, Mont.; J. A. Flint, Three Forks; and J. W. Johns, Huron, S. D. The company is capitalized for 2,500,000 shares, par value $1 each. It will take over and operate the famous Boss Tweed and Clipper gold claims, near Pony, Madison County, Mont., which formerly were owned by the late A. C. Burrage, of Boston. A small mill is now running at the property. The new owners plan to increase the capacity of the mill and connect with the line of the Montana Power Company.

At Roan Antelope, the completed headframe of the Beatty hoist shaft

Big Hill Shaft at 1,900 Ft.

Sinking of the Big Hill shaft of the North Lily-Knight Company, in the East Tintic district of Utah has reached a depth of 1,900 ft., where a pumping station is being cut. In the adjoining Eureka Bullion property, North Lily-Knight is sinking a winze on a mineralized zone in the Ophir formation, 600 ft. wide. This zone was exposed in driving the North Lily 1,200 level to connect with the Big Hill 1,600 level.

■

Nevada Has New Gold Find

Another district is making Nevada's mining men sit up and take notice. Fireball, 63 miles northeast of Reno, is the latest addition to the ranks of the State's boom camps. Ex-Governor Scrugham reports a stringer, 5 in. wide, that averages $3 in gold per pound. In addition, several ledges in the district, assaying from $25 to $225 per ton, are reported. This is at least the third strike within a year that has brought Nevada's gold-mining possibilities to the attention of the general press, the previous ones being at Scossa and near Yerington.

■

Ballard Gold to Reopen

Ballard Gold Mining has been formed by J. E. Johnson, Telena; Lee Yealey, Shelby; F. C. Gilbert, Butte; C. L. Flanigan and W. L. Jensen, Great Falls, to operate the old Ballard mine, in the Woodland Park district 12 miles east of Jefferson City, Jefferson County, Mont. The property has been worked by hand intermittently since 1902, shipments assaying over $80 per ton in gold. The new operators plan to install new and modern machinery. C. C. Mongold is superintendent and Prof. F. C. Gilbert, of the Montana School of Mines, is consulting engineer.

■

Ship Equipment for Montana Dredge

Material for constructing a dredge on the Lincoln Gulch Mining placer ground has been shipped from the factory. The company expects to start operations some time this summer on the Tatum placer, near Lincoln, in Lewis & Clark County, Mont., according to James LaFountain, manager.

Tonopah Belmont Acquires Mine Near Tuolumne

By Special Telegraph to "E.&M.J."

Reno, June 8.—Tonopah Belmont Development, which has closed down its properties in Nevada and Arizona, has taken over the Paragon mine, on the North Fork of the Tuolumne River, 10 miles southeast of the old camp of Tuolumne, Calif. The area of the holdings is about 140 acres. Clyde Heller, president of Tonopah Belmont Development, signed a lease and bond after exhaustive examination of the property by Roy King, who was mine superintendent of the Tonopah property and who will have charge of Tuolumne operations.

. . . . Present development of the orebody consists of one drift tunnel that has been driven about 100 ft. in on ore that averages $30 in gold per ton over a width of 3.5 ft. At a distance of 600 ft., another drift from a crosscut tunnel has shown $11 in gold per ton over the same width. Active development by Tonopah Belmont will start within ten days.

■

Six Months' Figures Show Cut in Utah Mine Output

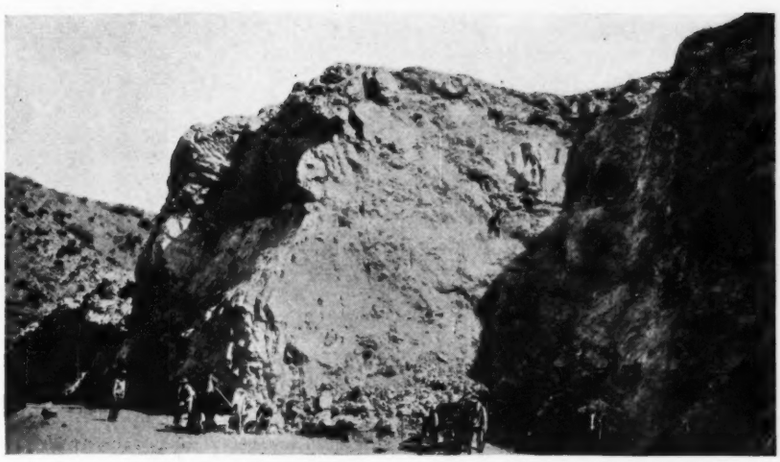
Figures for ore shipments from the Tintic and Park City districts of Utah during the first six months of 1931 reveal the extent of the reduction in mine output of these two important silver-lead camps when compared with 1930. The Tintic district reports a total of 1,952 carloads shipped, compared with 3,352 carloads in the same period of 1930, a reduction of about 40 per cent. Tintic Standard retained its position as the area's leading shipper, with a total of 960 carloads, or about 160 a month. Mammoth Mining, one of the oldest properties in the area, was second, with shipments of 321 carloads, followed by North Lily (180 carloads) and Plutus Mining, the Chief Consolidated subsidiary (154 carloads). Tintic Standard's output included that of Eureka Standard.

Park City production for the first six months of 1931 totaled 63,312 short tons of ore and concentrate. In 1930, output was 113,030 tons in the first six months. Park Utah shipped 33,746 tons of ore and concentrate and Silver King Coalition shipped 16,947 tons, almost entirely concentrate. Most of the remaining tonnage was shipped by Park City Consolidated, operating a silver property.

■

Park Bingham Pays Mortgage

Park Bingham Mining has paid the $70,000 mortgage due on its property at Bingham, Utah, to U. S. Smelting, Refining & Mining on July 1. Money for the payment of this mortgage was advanced to the company by Combined Metals Reduction, in exchange for a substantial stock interest in Park Bingham. The silver-lead-zinc property, totaling 51 claims of 375 acres, is developed by the Niagara and Butterfield tunnels of U.S.S.R.& M. as well as by the Silver Shield shaft, which connects with the Niagara tunnel. National Lead and Combined Metals, Inc., are the controlling interests in Combined Metals Reduction, which operates properties in Nevada and Utah.



Copper Cities' lime quarry, near Miami, Ariz.

Find Surface Sulphur Deposit Near Rio Grande, Mexico

Discovery has been made of a surface deposit of sulphur near the Rio Grande in Mexico, opposite Candelaria, Tex., and about 50 miles from Marfa. The deposit rises above the surface to a height of 10 to 25 ft. and has a depth that has not yet been ascertained. It is said to be almost pure sulphur. Several surface deposits of sulphur occur in the upper border region of Texas, but none contains sufficient quantities to be of commercial value. The largest of these deposits is in Culberson County. Ore from the deposit in Mexico would have to be transported by trucks or a line of railroad constructed to it from some point on the Southern Pacific.

■

Coppermines Cuts Output

Consolidated Coppermines, operating the Emma-Nevada and other properties in the Ely district of Nevada, is cutting production from 60,000 to 45,000 short tons of porphyry ore monthly. The new rate represents about 50 per cent of the usual tonnage under the company's contract with Nevada Consolidated. Actually, the management has stated that the properties can produce 250,000 tons a month, were the necessary metallurgical facilities available. Present curtailment results entirely from current economic conditions.

Nevada Consolidated, according to press reports, recently suspended production at its Nevada mines for several days. The company made no reduction in its working force, however.

■

Retort for Oregon Quicksilver Find

A small retort plant is being installed at the property of Maury Mountain Mining, near Post, Ore., where a high-grade deposit of cinnabar is reported to have been developed. The find was made in 1930 by F. S. Towner and was sold by him and his associates for $45,000 to the present company, according to a report in the Portland *Oregonian*. Development has been undertaken through two short tunnels, 50 ft. and 200 ft., respectively, below the original find. W. A. Castleton, of Seattle, is president and general manager of the company, with John Semple in charge of operations.

Silver Proponents to Meet in West This Month

A conference on silver may be held in Denver or Salt Lake City later this month, according to reports from Western papers. Senator King, of Utah, who has been active in asking for an international conference and who was the author of the silver resolution adopted at the meeting of the International Chamber of Commerce, in May, is sponsor for the conference. Former Senator Charles S. Thomas and other Western Senators are expected to join in the conference if it is held. There are indications that Senator King may make an effort to include silver in the moratorium on European war loans proposed by President Hoover.

Late in June, four representatives of Utah silver-mining companies conferred in Washington, D. C., with President Hoover, Assistant Secretary of Commerce Klein, and Senator Smoot, of Utah, over the effect of the silver situation on world economics. W. Mont Ferry, head of the Silver Producers' Association and managing director of Silver King Coalition; J. O. Elton, manager of International Smelting: E. J. Raddatz, president of Tintic Standard; and G. W. Snyder, manager of W. F. Snyder & Sons, which has mining interests in Utah and Nevada, were the mining men.

■

Reopen Ankerite, at Porcupine; May Unite With March

A Buffalo syndicate, consisting of the chief shareholders in the March Gold Mines, has purchased the Ankerite mine, in Porcupine, Ont., and is now unwatering the workings preparatory to further examination. Plans are expected to be made soon for the resumption of mining and milling. Some broken ore as well as blocked-out ore was left in the mine. As the property adjoins the March Gold, the backers believe that by combining operations a profit can be realized. Ankerite was formerly owned by the Porcupine Goldfields, an English company.

Production at March Gold continues to run about $20,000 in gold a month, with operating costs of about $4 a ton. A reorganization of March Gold is expected. This will probably result in an amalgamation, or at least a working arrangement, with the Ankerite.

Local Quarry Produces Lime for Miami Mines

A small but important adjunct of the copper mines at Miami, Ariz., is the Copper Cities' lime quarry at Radium, between Globe and Miami. It is owned and operated by a group of local men, and the greater part of the lime it produces is used at the Miami and Inspiration concentrators. There are four kilns at the quarry, and the output of each kiln is 10 short tons per day. Under present conditions only one kiln is being operated. The kilns consist of raises, driven from a tunnel level to the floor of the quarry 50 ft. above. They are about 4 ft. in diameter at top and bottom and are belled out to a diameter of 10 ft. at the middle. Firebrick is used for lining.

To break the limestone from the ledge, vertical holes are drilled with an Ingersoll Rand BCRW 430 plugger machine and are blasted with 30 per cent dynamite. Horses are used to haul the dump carts of limestone from the face to the tops of the kilns. Anthracite pea is used to burn the lime and is dumped in at the top of the kiln with the limestone in the proportion of one part coal to three parts limestone. The latter is broken into lumps smaller than 12-in. Curing requires 36 hours. The kiln is kept full all the time, the limestone and coal being added from above as fast as the cured lime is drawn off from the bottom of the kiln. At the bottom of each kiln is a concrete chute through which the cured lime is drawn into small mine cars, in which it is trammed by hand on the tunnel level to bins which discharge into trucks for transportation to the concentrators.

Other products of the quarry are rock for concrete aggregate, track ballast, and yard chat of gravel. The rock products are made from limestone not pure enough for making lime. They are crushed in a small jaw crusher and sized in a trommel. A 40-hp. Fairbanks-Morse gas engine furnishes power for the trommel, crusher, and a two-machine Ingersoll Rand compressor. The payroll carries from 15 to 30 men, depending on the demand for the products.

■

Suspend Work at Chelan

Operations at the Chelan copper property, in central Washington, have been suspended by Howe Sound. Development work here has exposed a promising copper deposit, of low grade but of sufficient magnitude to warrant construction of a mill when conditions improve. The suspension has been caused entirely by the current economic situation and the desire of the company to conserve its resources. Work will be resumed as soon as metal prices improve sufficiently. A little more than 100 men were employed at the property prior to suspension at the end of June. The company's other operations will not be affected.

■

Close Deal for Verde Central

A deed conveying claims near Jerome, Ariz., belonging to the Verde Central Mines company to United Verde Copper has been filed in the Yavapai County recorder's office at Prescott. The consideration was $250,000 and included mining and milling equipment. Calumet & Arizona controls Verde Central.

Rukeyser Sues Amtorg for Russian Contract Breach

Walter A. Rukeyser, who, for a considerable period, was chief consultant to Uralasbest, Russian asbestos-mining trust, has brought action against the Amtorg Trading Corporation, the commercial representative of the U.S.S.R. in the United States. Included in Mr. Rukeyser's suit as co-defendants are Archil V. Mikadze, vice-president of the corporation; C. Vernon Smith, formerly Rukeyser's assistant and now his successor; Nathan Newman, president of Asbestos, Ltd.; and Ivan Paramnoff, president of Uralasbest. The suit, concerning which the first news appeared on June 26, came as a great surprise, as Mr. Rukeyser had recently completed publication of a series of articles in *The Nation,* the general tenor of which was distinctly favorable to the Soviet régime in Russia.

Mr. Rukeyser's suit charges conspiracy to bring about a breach of his contract with Uralasbest (calling for $60,000 for two years' work) and conspiracy to steal patents, processes, and ideas. The contract, signed with Amtorg, Mr. Rukeyser maintains, was to run from June 17, 1930, to July 16, 1932. In December, 1930, it was abrogated, after he had received $18,000. In addition to the $42,000 he declares is due him in accordance with the contract, Mr. Rukeyser is asking for $208,000 for damage resulting from the loss of professional reputation because of false and slanderous statements alleged to have been disseminated.

Amtorg Trading Corporation replied to the charges by stating that the agreement under which Mr. Rukeyser was working specified a method by which it could be annulled and that, after nine months, Uralasbest informed Mr. Rukeyser that in view of unsatisfactory services and nonfulfillment of certain points of the agreement, his services were no longer required. Mr. Rukeyser, Amtorg declares, never made any claims in the manner provided for in the agreement. It disclaims, furthermore, having had any participation in the actual contract preparation.

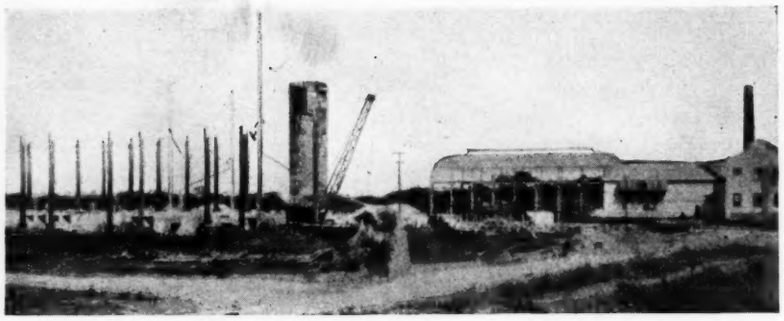
To this denial, which was published in the New York *Times* and other metropolitan newspapers, Mr. Rukeyser has replied that he is not suing under the contract and that he has admitted that such action would be impossible in this country, because of non-recognition of Russia. His suit, he declares, is entirely concerned with the existence of a conspiracy to deprive him of his contract and his standing. Amtorg has not made a satisfactory answer to this aspect of the case, he maintains.

Mr. Mikadze, Amtorg vice-president, who was about to sail when the suit was brought, was arrested and then released on $100,000 bail. The suit will be heard in the New York State Supreme Court, probably some time next fall.

■

Purchase Sonora Gold Property

B. B. Buckeridge, of Fort Worth, Tex., representing the International Mining Company, states that his company has purchased the Los Mulattos gold property, in central Sonora, Mexico, from J. E. Cocker and others, and that operation of the mine will be started by Oct. 15 of this year. The property is an old one, having been originally opened by Jesuit missionaries. Headquarters for the company will be in Nogales, Ariz.



Starting on the stack for the new N'Kana copper smelter, in Rhodesia

Recess Declared in Hearing of Coppermines-Nevada Suit

After 71 days spent in the Nevada district court, at Carson, in the presentation of testimony on the counterclaims of Consolidated Coppermines by attorneys for that company and Nevada Consolidated Copper, a recess was taken on June 26 until some date in November. The suit was originated by Nevada Consolidated in 1929 to secure judicial interpretation of the terms of a contract entered into between the two companies in 1926. Judge Frank H. Norcross will hear completion of evidence, argument, and submission. The recess was due to Judge Norcross's engagements in other federal courts.

A daily transcript of the testimony on the counterclaims, running into well over 5,000 typewritten pages, is now on file with the clerk of the federal court. The testimony on the fourteenth counterclaim has been in the course of presentation since April 17 and will be resumed after the recess. When the recess was taken, the defense of Nevada Consolidated was well under way, but it is estimated that several months will be required when the hearing is resumed to wind up the presentation of the matter.

■

City Deep Plans Cut in Output as Operating Losses Continue

City Deep, second deepest mine on the Witwatersrand, Transvaal, and a large producer of gold since 1910, has been forced to reorganize the basis of its operations to avoid continuation of operating losses (in 1930, £39,908). Production, which was nearly 100,000 tons of ore monthly in 1930, will be reduced to a basis of 75,000 to 80,000 tons. This will result in relatively improving the ore-reserve situation (on Dec. 31, ore reserves were 1,268,200 tons of an average value of 5.98 dwt. over a width of only 42.8 in.).

No. 1 main vertical and incline shafts will not be used for hoisting ore hereafter, as the new No. 1C sub-incline shaft will be available after completion of the ore-pass system. Ore from the eastern section of the mine will then be transported by the No. 26 haulage level to the Nos. 2 and 4 western shafts.

The average yield at City Deep in recent months has been about 21s. 10d., compared with working costs of about 22s. 4d. per ton. The costs are among the highest and the grade is among the lowest on the Rand. When the company began to incur losses in 1928 and 1929, underground work was reorganized to improve the position. Although operations were maintained at full scale and improved methods of stoping were introduced, the continued decline in the value of ore developed more than counterbalanced improved technology.

■

Ruth and Greenawalt Win Suits Over Flotation Patents

Joseph P. Ruth and William Greenawalt, Denver metallurgists, have been awarded the decision in their separate suits for patent infringement on the part of the Minerals Separation North American Corporation, a subsidiary of Minerals Separation, of London. The suits were brought against the Stearns-Roger Manufacturing Company, of Denver, which holds a license for the manufacture of Minerals Separation flotation equipment, in which the infringement was alleged. Judge J. Foster Symes, of the Federal District Court, in Denver, heard the case. An accounting of profits will be undertaken to determine the damages due Ruth and Greenawalt.

The trial lasted two or three weeks and attracted considerable attention. Expert witnesses included Rudolf Gahl, consulting metallurgist, of Berkeley, Calif.; T. A. Janney, of Utah Copper at Bingham; Arthur H. Higgins, consulting metallurgist, of London; and others. The patent rights which were infringed, according to the decision, were held by J. A. Pierce, of Idaho Springs, Colo., and patented in 1917.

■

Corpus Christi Phosphate Shell Deposit May Be Sold

Preliminary to the sale of a deposit of phosphate shell, discovered recently in the shallow waters of the Laguna Madre between Corpus Christi and Port Isabel, Texas, the State Fish, Game and Oyster Commission will hold a meeting on July 19, for the purpose of fixing the price per ton for the shell. It has been estimated by Dr. Livingstone Anderson, who discovered the deposits, that it contains more than 400,000,000 short tons of shell, which assays show to have an available phosphate acid content of 26 to 79 per cent and from 92 to 98 per cent of bone phosphate of lime. Dr. Anderson has applied to the Fish, Game and Oyster Commission for permission to purchase the deposit from the state. The survey now being made shows that most of the shell deposit is above water and that the greatest depth of water covering any part of it is only 4 ft.

Consolidated M.&S. Prepares to Resume Work in Goudreau

Consolidated Mining & Smelting is sampling the McCarthy Webb Goudreau Mines property, at Goudreau, Ont., preparatory to resuming exploration. Work on this property, which carries low-grade gold deposits, was halted by litigation two years ago. The lawsuit between the McCarthy Webb company and the original owners of the property has made possible resumption of development under the terms of a new option.

The property consists of seven patented claims, totaling 322 acres, near Sault Ste. Marie. Gold occurs in quartz veins, in a wide mineralized zone, by a porphyry-greenstone contact. Diamond drilling of the property was undertaken in 1926, 1927, and 1928.

An option on the property of the Three Duck Lake syndicate, in Chester Township, has been dropped. This district is attracting numerous prospectors, and several small gold finds are reported.

■

Perrault Formally Opens New Quebec Copper Refinery

Quebec's first copper refinery, the plant of Canadian Copper Refiners, in Montreal East, was officially opened on June 25, by the Hon. J. E. Perrault, Minister of Highways and Mines of Quebec, who spent the afternoon inspecting the property with officials of of the company and a group of prominent financiers and industrialists from Canada and the United States. The new plant of the Canada Wire & Cable Company, a $1,000,000 investment, built on the same property, was started simultaneously.

Canadian Copper Refiners, Ltd., is owned by Noranda Mines, the British Metals Corporation, and Nichols Copper. Noranda Mines also has an interest in Canada Wire & Cable. Refinery capacity is 75,000 tons of copper annually. It will employ about 300. The wire plant can handle 40,000 tons annually and will employ about 150 men when in regular operation.

■

Tocopilla Ore Reserves Higher; Plans Panulcillo Mill

On Dec. 31, 1930, Tocopilla Mining, operating a property at Tocopilla, Chile, estimates its reserves at 230,605 metric tons of ore, averaging 5.5 per cent copper, an increase of about 40,000 tons over the reserves at the end of 1929. In 1930, Tocopilla mined 16,323 metric tons of direct-smelting ore, which averaged 14.7 per cent copper, and 69,735 tons of concentrating ore, averaging 3.8 per cent copper, from which 8,639 tons of concentrate, averaging 26.9 per cent copper, was produced. Development work done totaled 1,717 m. Of this, 78.9 m. was driven in direct-smelting ore, 756 m. in mill-grade ore, and 882 m. in unpayable material.

At the company's Panulcillo exploration project, in Coquimbo, development has confirmed the expectations held at the time the properties were taken over. Sufficient ore has been put in sight in the Inagotable, Verde, and Cocinera properties to justify construction of a 400-ton mill. Because of the drop in the price of copper, however, the company has decided that a 200-ton unit will be sufficient for the present. The preliminary plan of this unit has now been completed. In the Panulcillo mine proper, development at depth is being continued.

■

Mining Exhibit to Feature Arizona State Fair

W. Val De Camp, general manager of United Verde Copper, is in charge of the mining exhibit which will be shown at the Northern Arizona State Fair. Models of a reverberatory furnace and of the United Verde open pit and a special collection of ores from the United Verde mine, including some polished sections, will be on display. George Fansett, of the Arizona Bureau of Mines, will demonstrate a special flotation machine and prospectors' mineralogy equipment. Mr. Fansett recently completed giving a series of addresses in different parts of the State in which he discussed the various methods of gold recovery. A display of ores from Mohave County is to be under the direction of L. V. Root. Special exhibits from Coconino County will be displayed under the direction of the Flagstaff Chamber of Commerce and will include specimens from Grand Canyon properties. Descriptive material and facts pertaining to Arizona's efforts to bring about a protective tariff for copper will be available.

■

High-Silver Ore From Alta, Utah

Mineral Veins Coalition Mines recently shipped a carload of ore from its Columbus Rexall property, at Alta, Utah, assaying 39 per cent lead, 2.5 per cent zinc, 95 oz. of silver, and $1.80 in gold per ton. The company is also developing ore above the Wasatch Drain tunnel in the Columbus Con group. Ore is being mined in the Flagstaff carrying lead, silver, and $11 in gold per ton.

■

Ontario Graphite Mine Closes

The Black Donald Graphite mine at Calabogie, Ont., has been closed down, presumably for lack of a market, according to advices received by the Ontario Department of Mines. This is the only producer of graphite in Ontario and employed about 60 men. Annual production averaged around 1,000 tons, and in 1929 reached as high as 1,288 tons, valued at $90,522. R. F. Bunting is manager.

■

Quincy Again in Operation

Quincy Mining, which was shut down on June 17 for three weeks, resumed operations at its property, near Hancock, Mich., on Wednesday, July 8. The former basis of five days a week prevails. No change in operating policy has been made, and all men employed when work was stopped in June were taken back. Rent on houses occupied by employes was remitted during the lay-off. Quincy was producing around 1,000,000 lb. of copper per month when work was suspended.

Helium in Michigan Copper May Determine Age

Dr. W. D. Urry, of Johns Hopkins University, is in the Michigan copper district to start an investigation of the amount of helium in the rocks for the purpose of calculating their age. Dr. Urry worked with Prof. Paneth in Germany and together they refined the methods of determining extremely small quantities of helium, to a million-millionth of a gram, a number of technical papers having been published in regard to this work. The helium is produced by the disintegration of radium, and upon the ratio of helium to radium Paneth and Urry have made estimates of the age of various meteorites, which vary up to about three thousand million years. It is now their purpose to apply the same method to copper and the rocks which contain it. Dr. Urry will not be able to give any results while here. He is only taking rock samples, under special precautions, to be later submitted to a refined analysis, for which purpose he must take them to Germany. The Michigan College of Mining and Technology is cooperating with him.

■

Mohawk Drifts on Evergreen

Drifting along the Evergreen lode, on the No. 15 level of the "E" shaft at its Michigan mine, Ontonagon County, Mich., is being continued by Mohawk Mining. The crosscut at this depth showed rich mass copper in the Evergreen, although the Butler lode, expected to be the most favorable for deposition of orebodies, showed no ore. Drifting that has already been done along the Evergreen continues to develop rich copper rock. The company will continue this work as long as the grade persists, but the orebody will not be considered commercial unless several hundred feet long. The Butler is still regarded as the best bet.

■

Discontinue P. D. Pension Plan

Phelps Dodge directors have announced discontinuance of the pension plan of the Copper Queen Branch, effective July 1, 1931. Payments will be continued to retired employees now receiving a pension in the same amounts they are now receiving. Rights of employees who have completed nineteen years or more of eligible pension service will be adjusted.

■

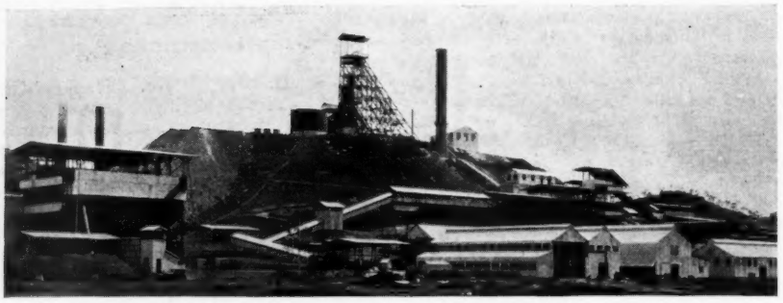
Decision Made in Lehi Tintic Suit

In the case of E. H. Weaver against E. R. Woolley, president and general manager of Lehi Tintic Mining, Judge Tillman D. Johnson of the General District Court ruled that Woolley should return 2,032,000 shares and $20,000 to the treasury before Aug. 1. The suit involved possession of the shares in the company, operating in the Tintic district of Utah.

■

Ohio Keating Opens New Ore

The Ohio Keating property at Radersburg, Broadwater County, Mont., has been reopened and is being operated by C. L. Hewitt. Recently a new gold deposit was opened. Mr. Hewitt will probably build a fine-grinding cyanide plant to treat the lower-grade ores.



The Urquhart shaft and the lead smelter of Mount Isa Mines, in Queensland, which have been producing since May

San Rafael Develops Ore on Deep Levels at Pachuca

Development of the No. 1 vein of the San Rafael y Anexas silver property, in the Pachuca district, Hidalgo, Mexico, has yielded good results, according to the annual report. Ore is being opened on the 550 and 575-m. levels, the deepest in the property. Grade is better than average. Results obtained in developing the No. 2 vein have been generally satisfactory, although much work must still be done to establish the importance of the ore-bodies, which are irregular both in grade and in occurrence.

The Soledad shaft has now been deepened to 575 m. (the bottom of the shaft is actually 5 m. below the level) and a crosscut is being driven to the No. 1 vein. Production through the company's three shafts totaled 124,658 metric tons of ore in 1930, of which the Sorpresa shaft contributed about 60 per cent. Grade was 496 grams of silver and 2.68 grams of gold per ton. Ore reserves at the end of the year were estimated at 174,322 metric tons, averaging 672 grams in silver per ton and 2.84 grams of gold. The company's cyanide plant made an average recovery of 94.9 per cent of the metal content of the ore in 1930.

■

Boleo Reports Good Results in Southern Area Work

At the annual meeting of Boleo Copper, held in Paris on June 15, M. d'Eichthal, president of the company, discussed the results of development work on the southern section of the property, in Baja California, Mexico. The probable tonnage of ore has been greatly increased and the life of the company, which has been one of Mexico's largest copper producers, has been considerably extended. Preparations are being made to establish a new mining center in the valley of Santa Agueda. The board of directors has authorized the expenditure of $500,000 to equip this new ore deposit.

The company has agreed to curtail its production somewhat, in line with the curtailment of other copper producers, but unless the low price of copper is unusually prolonged, suspension will not be considered. Costs have been cut considerably, but the company is losing money. (Ed. Note—A report from Hermosillo, Mexico, states that copper production has been curtailed. It has been about 1,000 metric tons monthly. Work on construction of new homes for workers has been suspended and the number of men employed has been reduced.)

New Handling Equipment at Tampico Is Planned

The Tampico Stevedores' Union announces that it plans to install automatic machinery and elevators to facilitate the loading of ore at the Mexican port. Property for this purpose has been leased and preliminary improvements made on structures. The union is negotiating with an American ore-elevator manufacturer. Work is expected to start in September. The undertaking, which will represent an investment of from $250,000 to $300,000, is expected to increase Tampico's importance as an ore-shipping center.

Shipments of metals and ores through Tampico from January to May amounted to 122,253 tons, according to figures of the Tampico Stevedores' Union. Most of these exports were to Europe. Exports included 63,791 metric tons of metal, chiefly copper and lead, and 58,461 tons of ore and concentrates, principally zinc concentrates.

■

Cananea Buys Democrata Area

Officials of Cananea Consolidated Copper, Mexican subsidiary of Greene Cananea, have announced the purchase of the properties of Democrata Mining, in the Cananea district, Sonora. Seventeen pertenencias of about 35 acres, entirely surrounded by the property of Cananea Consolidated, are involved in the transaction. The property is about half a mile north of the Colorada shaft, and east of the town of Cananea. The Democrata mine is one of the oldest properties in the Cananea district and was a part of the Hoffman estate, of Cincinnati. Operations began in the early 'nineties, some years before the opening of Greene-Cananea Copper. Active operation of the Democrata was discontinued in 1920, at which time the mill was dismantled. The management has no intention to operate the property at the present time.

■

Buy Arizona Feldspar Quarry

Consolidated Feldspar Corporation, of Trenton, N. J., has purchased the business of Flynt Silica & Spar, of Los Angeles. The new company plans to erect a feldspar grinding plant at Kingman, Ariz. The Flynt company operated a feldspar quarry 6 miles out of Kingman and shipped its product to Los Angeles, where it was prepared for the market. Recently the grinding plant was destroyed by fire. The Flynt company supplied feldspar, acoustic pumice, abrasive silica, and ground mica.

Broken Hill Pty. Options Victoria Gold Property

By Special Cable to "E.&M.J."

Melbourne, June 27.—Broken Hill Proprietary has taken a twelve months' option on the Kingston property, near Stawell, Victoria, which carries a low-grade gold deposit. The company has been searching for such a property for some time, in view of the current depression, which has forced it to close its lead-zinc property in New South Wales and to work its other interests at less than capacity. According to reports, the Kingston has a strong lode, 2,500 ft. long and 40 ft. wide. About 100,000 tons of low-grade ore is in sight above the 250 level. With a year in which to develop it, Broken Hill Proprietary should be able to give the property a thorough trial.

. . . . In May, Victoria produced 4,196 fine oz. of gold, an increase of 2,016 oz. compared with production in May, 1930. Estimates place the number of prospectors at work throughout the state at about 10,000, many of whom are partly supported by State and municipal funds. An estimate made by the Mines Department of Victoria places the value of gold produced during the first four months by subsidized prospectors at £8,000.

. . . . May gold production of Western Australia, the most important gold producer among the Australian states, was 38,265 oz., valued at £162,503. In May, 1930, it was 32,967 oz., indicating an increase of 5,298 oz. Final figures for 1930, just made available, show a total of 645,344 long tons of ore treated for a recovery of £1,788,056 in gold. This is an increase of 16,944 tons of ore, £207,629 in gold, and 5s. per ton in grade compared with 1929 figures. Dividends in 1930 were only £31,250, a decrease of £34,000.

. . . . Lake View & Star now announces that its flotation plant at Kalgoorlie, Western Australia, will be able to treat 20,000 long tons of ore monthly by October of this year and that it will reach its full capacity of 30,000 tons monthly early in 1932. When the latter capacity is reached, all-over costs are expected to be only 20s. 3d. per ton, which sound more like the Witwatersrand than Kalgoorlie. At present, Lake View & Star is treating about 16,000 tons monthly, of which nearly half is custom ore from leasers. Less than a third is being put through the flotation unit, however. New Consolidated Gold Fields has agreed to finance any necessary construction. Dependent on the success of the enlarged flotation plant, further additions to capacity are contemplated.

. . . . From April 18 to June 6, 226 long tons of supplies and materials for the new dredges of Bulolo Dredging, in the Wau gold field, New Guinea, were transported to the property from the coast by the Junkers planes especially constructed for the purpose. Ninety-three flights were made. Erection of the first of the two dredges is now proceeding. In preparation for the hydro-electric plant, 1,040 ft. of tunneling has been completed and 700 ft. remains to be driven. Bulolo Dredging, a subsidiary of Placer Development, now has 70 white and 300 colored employees.

. . . . Broken Hill South, New South Wales lead-zinc producer, has closed its property at Broken Hill for a week, in accordance with the curtailment scheme whereby it will shut down its entire operations for one week out of every seven. Production is normally about 60,000 tons of lead concentrate and 45,000 tons of zinc concentrate annually. North Broken Hill, largest of the Broken Hill producers, has purchased the adjoining Junction North mine for £2,750. The property consists of only 45 acres, and operations have been suspended for some time. The company had a capitalization of £375,000, of which £293,116 was issued; was organized in 1912; and paid dividends from 1917 intermittently until 1926. The last accounts showed reserves of £57,124.

. . . . Sulphide Corporation has closed its Cockle Creek fertilizer and cement plants, near Newcastle, New South Wales, for a period of one year because of heavy stocks. The company's Broken Hill lead-zinc property was closed at the beginning of the year.

. . . . Mount Isa Mines, new Queensland lead producer, shipped its first consignment of 220 long tons of lead bullion in the middle of June. The bullion will be refined at the company's desilverizing plant in England, which will be able to handle 6,000 tons monthly. At present, tonnage of ore handled daily at Mount Isa is up to 1,400 tons, two sections of the concentrator being in operation.

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East Geduld to Start Milling This Month

By Special Cable to "E.&M.J."

Johannesburg, June 29.—Operation of the new cyanide plant of East Geduld, on the Far East Rand, Transvaal, will start in the middle of July. East Geduld is the first addition to the ranks of the large Witwatersrand gold producers in several years and is the forerunner of what is expected to be a new wave of increased production from new properties on the Far East Rand. Its cyanide plant will handle 60,000 tons of ore, averaging about 7 dwt. in gold per ton, a month. Development was done largely from the shafts in neighboring properties, notably Geduld Proprietary, which has a 35 per cent interest in East Geduld. A main hoisting shaft has since been put down to a depth of 3,225 ft., however, and reserves of ore on Dec. 31, 1930, were 3,900,000 short tons. During the first four months of 1931, an additional 2,902 ft. of development has been driven, of which 935 was in ore (only 1,630 ft. was driven in reef matter). The grade and width are well above mine average. Total expenditure from the inception of the company to the end of 1930 was £930,996. The unexpectedly large water flow encountered in sinking through the dolomite formation increased expenditures somewhat. This flow is now well under control.

. . . . Rhodesia Broken Hill Development is suspending operation of its electrolytic zinc plant, in Northern Rhodesia, because of low metal prices. The company, which operates the only zinc plant in Africa, has a normal output of 1,600 long tons monthly, but has recently been producing only about 1,200 tons a month. Several months ago, it suspended mining operations and has since been drawing on accumulated supplies of zinkiferous material for its charge. Production of vanadium oxide will continue. How many workers will be affected has not been reported.

. . . . Numerous encouraging gold discoveries have been reported in various districts of Southern Rhodesia. This is one important gold-producing territory that has not increased its output within the last two years. In fact, exhaustion of some of the older mines, such as the Shamva, has more than offset the increase resulting from operations at the new Wanderer plant. Current Rhodesian production is about 45,000 oz. monthly, with Cam & Motor as the largest individual producer.

. . . . Although no definite word is available, the current economic situation and the general interest in gold mining foreshadow several important amendments in the Transvaal gold law that will be favorable to the operations of the large companies. Government aid is considered necessary in making possible exploitation of low-grade deposits on the Rand.

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Predicts Further Expansion in Far East Rand

By Special Cable to "E.&M.J."

London, June 30.—C. F. Rowsell, chairman of the London board of directors of African & European Investment, stated at the annual meeting of the company, held last week, that development of the Grootvlei Proprietary Mines holdings, in the Far East Rand, Transvaal, would probably lead to opening up of the Palmeitkuil, Vlakfontein, and other properties in the southeast section of the district. Grootvlei, a huge block of ground, 7,241 acres in extent, lies between the East Geduld and Daggafontein properties, both of which are now preparing for production. (See also Johannesburg cable, this page.) Its development will be financed by Anglo-American Corporation, Union Corporation (which controls East Geduld), and African & European Investment, which owns 284,292 fully paid shares and 210,354 shares on which 5s. of the £1 par has been paid. A total of 611,770 shares have been issued by the company.

. . . . Annual report of Great Boulder Proprietary, operating in the Kalgoorlie district, Western Australia, states that development work done in 1931 added 98,121 long tons of ore to blocked-out reserves. Inasmuch as 91,429 tons were extracted, the reserves show a slight increase in volume to 87,060 tons. However, the grade has dropped from 9.7 dwt. to 8.99 dwt. in gold per ton. Total bullion production in 1930 was 80,207 oz. of gold, representing an extraction of 91 per cent of the content. Working costs were reduced 2s. 7d. per ton, but the grade of the ore handled dropped 9s. 9d. During the year, 1,226 ft. of drilling from the workings of the adjoining Boulder Perseverance property into Great Boulder territory gave generally good results on the "X" lode. Two crosscuts have been started to develop this orebody.

. . . . Lahat Mines, operating a tin property in the Federated Malay States, reports a loss of £121 on operations in 1930, compared with a profit of £5,869 in the preceding year. Production dropped 19 tons to 321 tons of tin concentrate, recovered from 239,110 cu.yd. of gravel treated. All production was suspended for two months, when work was started on the deviation of the Sorokai River and the plant was overhauled. The property was kept dry by one high-lift centrifugal pump.

. . . . The first shipment of lead bullion from Mount Isa started from Townsville, on the Queensland coast, on June 25. It is being shipped to the Mining Trust refinery at Northfleet, England.

. . . . Fire in the Nundydroog mine, which broke out in May and resulted in the death of nearly twoscore workers, is reported to be gradually subsiding, but the affected area on the 4,200 level is still inaccessible. The pumps are working regularly and are unwatering the lower levels. The management hopes to start stoping in the southern part of the mine when the unwatering is finished.

. . . . After revaluing its stock of metals on the basis of the lower prices now obtaining, Zinc Corporation, large Broken Hill lead-zinc producer, shows a loss of £41,874 in 1930, compared with a net profit of £246,050 in 1929. The allowance for revaluation of stocks was £146,000, indicating that actually an operating profit of more than £100,000 was realized. Development work has been curtailed, but ore reserves at the end of 1930 actually showed a substantial increase over those at the end of 1929—2,800,000 long tons, compared with 2,707,000 tons. Production in 1930 was 337,025 tons of ore.

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First Roan Mill Unit Exceeds Rated 1,000-Ton Capacity

By Special Cable to "E.&M.J."

London, July 6.—Operation of the first mill unit of the Roan Antelope concentrator, in Northern Rhodesia, has shown that capacity is higher than expected. Although rated at only 1,000 short tons of ore daily, the first unit is now handling 1,300 tons daily, with efficient recovery. During June the unit averaged 1,200 tons daily. The second unit was put into commission on June 25, and the entire tonnage treated in the month was 39,175, averaging 3.81 per cent copper. Production was 2,225 tons of concentrate, averaging 53.57 per cent copper. The first half of the month produced concentrate averaging about 50 per cent, indicating that the present grade must be over 55 per cent copper. Should the results obtained in the first unit hold true for the remainder of the plant, Roan may be able to produce 65,000 to 75,000 tons of copper annually with its present equipment.

. . . . Prompt deliveries of equipment for the mill being constructed at the N'Kana mine, combined with the progress being made in erecting the plant, apparently assure starting of production by Rhokana Corporation before the end of the current year. The N'Kana mill will be a 10,000-ton plant, to handle sulphide ore from the N'Changa and N'Changa West as well as the N'Kana mines.

BRIEF NOTES

Altar Reports New Ore. Discovery of a new vein of high-grade gold-silver ore is reported at the Altar Mining & Exploration property, at El Plomo, Sonora, Mexico. The vein, 3 ft. wide, was found in the Alberta raise of the Risueno claim. This company recently purchased a small smelter at Magdalena, Sonora, and moved it to El Plomo. It is controlled by Bisbee interests.

Bear Top Ships High-Grade. Three carloads of high-grade ore have been shipped by leasers operating at the Bear Top mine, near Prichard, in the Coeur d'Alene district of Idaho. Two cars contained 67 short tons, averaging 5-8 per cent lead and 4 oz. of silver per ton. The third car, weighing 38 tons, averaged 60.6 per cent lead and 4.6 oz. of silver. Development is being undertaken on the Simmons oreshoot through No. 2 tunnel workings.

Big Belt Sinks Shaft. The company, operating a gold placer property in Magpie Gulch, 4 miles from Canyon Ferry, Mont., is sinking a second shaft to bedrock to tap a bar on the north side of the gulch. The ground has been drained and the bedrock deposit will be worked by underground mining. The gold will be recovered by sluice boxes located close to the collar of the shaft. On July 4, 85 people attended a panning contest on the company's ground. Regular production has not yet started.

Blue Ridge Buys Pilot Place. The Pilot Place property, near Downieville, Calif., has been reported purchased by the Blue Ridge Gold Mines. An adit tunnel, tapping a Tertiary tunnel, will be extended and the gravel bed tested by raises.

Cariboo Cuts Ore at Depth. Cariboo Gold Quartz Mining, operating near Barkerville, B. C., reports that an important cross vein has been intersected by the new low-level tunnel at 276 ft. from the portal. More than 2,000 ft. of development has been performed on this property. A 94-hp. Diesel engine and a 400-cu.ft. compressor were installed last season.

General Metals Plans Deep Work. Sinking of the main shaft, now between 300 and 400 ft. deep, at the Kaaba Mines property, near Nighthawk, Wash., is planned by General Metals, a Vancouver company which has a lease on the property. In addition, the mill on the property will be remodeled to permit profitable treatment of the complex sulphide ore, in which gold, silver, copper, and lead occur. The shaft will be carried to about 1,000 ft. to permit development of the deposits, which occur as two fissure veins in granodiorite.

Golden Horseshoe May Expand. At Placerville, Calif., Golden Horseshoe Mining is treating about 50 short tons of gold ore daily in the ten-stamp mill. Plans to increase milling capacity to 100 tons daily are being considered. The company is continuing development work through the Fortuna shaft and tunnels on the Guildford property.

Green Gold Ships Ore. A carload of high-grade gold ore has been shipped to the International Smelting plant, in Utah, by Green Gold Mining, operating at Gilbert, Nev. Some time ago, the company shipped a carload to the Millers plant of Tonopah Mining and received returns of $30 per ton on material broken in sinking the shaft. The work of shaft sinking has been halted at about 85 ft. because of a heavy water flow. C. D. Wilkinson is in charge of the property.

Howey May Step Tonnage Up. Stockholders in Howey Mines, operating a gold property at Red Lake, Ont., have been informed that the management is considering a plan to raise the daily tonnage mined to 900 short tons daily. Of this, about 150 tons will be sorted out and the remaining 750 tons will be put through the cyanide plant, which has recently been averaging about 500 tons daily. Monthly gold output is about $70,000. Ore reserves either broken or blocked out in stopes are estimated at 879,379 tons.

McLeod River Delayed. Difficulty encountered in obtaining timber for the hull of the new McLeod River dredge, in Alberta, has prevented the company from attempting gold recovery. All the machinery is on hand and negotiations have been completed for a loan of $52,000 to finance completion of the unit. Operation is now expected to start in August.

Otavi Closing Down. Otavi Mines & Railway, operating the Tsumeb lead-copper deposit, in British South West Africa, has closed down because of low metal prices. The company is a fairly large producer and ships matte and other products to German metallurgical plants. In the year ended March 31, 1930, the last for which we have figures, Otavi produced ore and matte containing 12,510 long tons of copper, 20,209 tons of lead, and 892,450 oz. of silver.

Pend Oreille Output Rising. According to Spokane reports, production of concentrate by Pend Oreille Mines & Metals, operating in the Metaline Falls district of Washington, is now about a carload a day. The company produces zinc concentrate, shipped to the American Zinc smelter, at East St. Louis, Ill., and lead concentrate, shipped to the Bunker Hill smelter, in Idaho. Most of the ore is coming from the 300 level. Addition of men to the night shift and installation of new hoisting equipment have made increased output possible.

Poderosa Suspends Shipments. Poderosa Mining, operating a property in the Collahuasi district, Tarapaca, Chile, has suspended production and reduced development expenditure. The company cannot produce at a profit below 12.5c. a pound of copper. In 1930, output was 10,695 long tons of shipping ore, assaying 23 per cent copper and 8.18 oz. of silver per ton. Despite increased development done during the year, no addition was made to the ore reserves, now 20,000 tons averaging 15 per cent copper. The manager recommends continuation of exploratory work on the Poderosa lode at No. 8 level, and sinking of No. 2 main winze to No. 11 and eventually No. 12 levels, to develop San Carlos lode, which on No. 10 level carries ore over a length of 75 m. averaging 25 per cent copper over a width of 1.25 m. The new 300-hp. Diesel unit is now at the mine, and the power house is being completed, but the machinery will not be installed for the present.

Reno Gold Develops Sulphides. Recent development at the property, on Sheep Creek, British Columbia, has penetrated the sulphide zone on the Nos. 3 and 4 levels, where grade is equal to, or better than, in the shallow oxide workings. Oreshoots of greater length and better widths have been found in this region, where the presence of sulphides of iron, lead, and zinc in the vein suggests its primary origin. Preparations are now being made to start No. 5 tunnel at mill elevation, which will give about 260 ft. of additional backs. Special attention will be paid to development of ore reserves, and prospecting of the lower levels by portable diamond drill is now in progress. During May, the Reno produced $11,300 gross, a decrease of $4,800 compared with April. The drop resulted from the wet condition of the oxide stopes that prevails at this season of the year.

Sherritt Gordon to Continue. A careful review of the first three months' operation of the Sherritt Gordon mine, in northern Manitoba, has shown that such results have been obtained as to justify keeping the property, as at present, in operation at one-third of capacity, or 600 tons daily. Both in extractions and costs the estimates previously made have been bettered. The decision to continue was made at a directors' meeting recently held in Toronto.

Sunshine Drifting at Depth. Drifting east and west along the Polaris vein on the 1,700 level of the Sunshine Mining property, in the Coeur d'Alene district, has developed about 350 ft. of ore to date, with an average width of about 8 ft. and a grade considerably above mine average. In addition, on the 200 and 700 levels, some new ore showings have been developed.

Texona Exercises Option. An option on the nineteen claims comprising the North Venture group, near Wickenburg, Ariz., has been exercised by Texona Mining, following a short drilling campaign. Three holes were put down to depths of 700 to 1,000 ft., to explore veins said to be similar to those on the near-by Vulture property. No details of the results obtained have been released. Al Irvine and George Steadman, of Phoenix, owned the Texona property.

Tungsten Mines Mill Ready. Construction of the new concentrator of Tungsten Mines, west of Addy, Stevens County, Wash., was completed during the first week of July, and operation was expected to start within an additional week, according to James Reed, president of the company. Mill capacity is 75 tons daily, but only one shift will be run for the present. Development of the orebody is through a tunnel and a raise to the surface, a distance of 100 ft.

Warrior Gold Plans Small Mill. Although at present shipping about 100 short tons of ore monthly, Warrior Gold, operating a property near Simon, Nev., plans to build a small mill to treat ore below shipping grade. The company has put two shafts down to 200 ft. They have been connected by a drift at this depth, a distance of about 300 ft. The shipping ore, said to grade about $35 a ton in gold, is being sent to the American Smelting & Refining plant, at Garfield, Utah.

MARKET AND FINANCIAL NEWS

U. S. Quicksilver Output Lower in 1930

The domestic output of quicksilver in 1930 amounted to 21,553 flasks, valued at $2,478,789, compared with 23,682 flasks, valued at $2,892,638, in 1929, according to the U. S. Bureau of Mines. The average quoted price at New York was 6 per cent below that in 1929. Apparent consumption declined 35 per cent.

By a wide margin California was again the leading quicksilver-producing state in 1930, with an output of 11,451 flasks. California and Texas were the only important producing states to increase their output. The production in California in 1930 was made by 40 operators, and in 1929 the output of 10,139 flasks was made by 29 operators. Nevada's output declined 31 per cent in 1930, from 4,764 flasks in 1929 to 3,282 flasks, but it was large enough again to place Nevada second in importance. As in 1929, Oregon ranked third in 1930, with an output of 2,919 flasks, compared with 3,657 flasks in 1929. The output of Texas showed an increase in 1930 while production in Arizona decreased sharply. Production for Texas, Arizona, and Alaska amounted to 2,822 flasks in 1930, as compared with 3,725 flasks in 1929. No quicksilver production was reported from the treatment of pan-amalgamation tailings in 1930.

During 1930 the principal quicksilver-producing mines in California were the Cuddeback mine, Kern County; Sulphur Bank and Red Elephant mines, Lake County; La Joya, Oat Hill, Bella Oak, and Knoxville mines, Napa County; New Idria mine, San Benito County; Oceanic and Rinconada mines, San Luis Obispo County; Cloverdale mine, Sonoma County; and Altoona mine, Trinity County. In Nevada the B. & B. and Red Rock properties, Esmeralda County; Sentinel mine, Nye County; the Juniper and Montgomery and Pershing mines, Pershing County; and Castle Peak mine, Storey County, led. The Black Butte mine, Lane County, and the Opalite mine, Malheur County, in Oregon; the Big Bend, Chisos, and Rainbok mines, Brewster County, in Texas; and the mine of Morton Cinnabar, Lewis County, in Washington, were the remaining important sources.

Imported quicksilver in 1930 was 2,943 flasks, valued at $295,829, as compared with 14,292 flasks, valued at $1,447,142, in 1929. Of the total in 1930, 2,802 flasks was reported as received from Spain and 141 flasks from Mexico. The 14,292 flasks imported in 1929 was credited to the following countries: Spain, 9,412 flasks; Belgium, 1,249 flasks; Mexico, 1,209 flasks; Italy, 892 flasks; Germany, 701 flasks; Canada, 493 flasks; France, 323 flasks; and Peru, 13 flasks.

Production in the United States plus imports for consumption and with allowances for exports, which have not been separately recorded since 1926, indicate that 25,200 flasks was made available for consumption in 1930 as compared with 38,500 flasks in 1929.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54
1928	99.78
1929	110.33
1930	82.87

	1929	1930	1931
January	106.86	102.94	67.62
February	110.37	102.28	65.90
March	122.71	99.93	68.03
April	116.36	93.24	64.45
May	110.03	83.41	59.81
June	109.66	78.57	58.23
July	109.58	74.58	....
August	109.81	74.41	....
September	109.29	73.42	....
October	108.52	69.63	....
November	106.09	71.39	....
December	104.75	70.65	....

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TECK-HUGHES GOLD reports production of $1,757,722 in the quarter ended May 31. An operating profit of $1,174,826 and a net profit of $979,105 were realized.

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BOLEO COPPER reports a net loss of 3,707,393 fr. in 1930. The company operates a copper property in Mexico. In 1929, net profit was 24,904,285 fr. Productionu in 1930 was 12,600 metric tons. Average price received for copper was 11.664c. per pound, compared with 18.095c. received in 1929.

Indian Copper Net Profit

In 1930, Indian Copper Corporation reports a profit of £47,391, after interest charges and general expenses. In 1929, the company netted £45,415. The increase resulted from larger production in 1930, as the price of copper was much lower. Total value of production was £207,584, representing an output of 2,974 long tons of refined copper. At the end of the year, the company had a balance of £35,760, compared with £9,760 at the beginning. Total assets were £816,449, including £5,135 in cash, £78,879 in metal stocks on hand, and £15,527 in accounts receivable.

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San Rafael y Anexas Report

Negociacion Minera de San Rafael y Anexas, S. A., operating a silver property at Pachuca, Hidalgo, Mexico, reports a net profit of 92,118 pesos in 1930. The value of the production was 1,837,221 pesos, which included 59,168 kg. of silver and 319 kg. of gold. The company has current liabilities of 143,489 pesos, and capital-and-surplus of 946,270 pesos. The property account has been entirely written off in the assets, with the exception of two small investments in mines other than the main property. Current assets include 363,909 pesos for metals and supplies on hand, as well as 684,450 pesos in cash and bonds.

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Mining Shares Dividend $3

On June 30, Mining Shares Corporation paid a $3 dividend to its stockholders. The company, a private mining-investment company, was formed in January, 1928, and has paid an average dividend of $8 annually for the years 1928, 1929, and 1930. All stockholders in Mining Shares are connected in some capacity with the mining industry. The officers of the company are Thomas Bardon, president; Robert D. Hoffman, vice-president; and Norman LaMond, secretary and treasurer. Messrs. Bardon and Lamond are vice-president and secretary, respectively, of Shattuck Denn Mining Corporation. It is interesting to note that at least one mining-investment company has been able to continue its dividends through the period of financial depression and to maintain its capital intact.

Debt Problem Factor in German Metal Market

DR. JAMES RUBINFELD
BERLIN

Activity in the German non-ferrous metal industry during the last month has been governed largely by the budgetary and reparation problems. The outlook early in June was anything but favorable, and business everywhere was held down to a minimum.

Imports of copper by Germany in the first four months of this year amounted to 60,800 metric tons, a monthly average of 15,200 tons. In the same period last year the imports amounted to 41,600 metric tons. The fact that French imports of copper are nearing the German import figures is attracting much attention. During the first quarter of 1931, France imported 42,495 metric tons of copper, a monthly average of 14,165 tons. France exports little copper, which makes the figures even more significant. However, the French demand for copper may be explained by the extensive railway electrification projects and a tendency to accumulate supplies at prevailing low levels.

Comment on the formation of Metallzentrale G.m.b.H. in Berlin as an agency of American Metal, under the management of Carl Sussman, formerly of Mansfeld Copper, has been varied. Trading agencies in France, it is pointed out here, have not been doing so well. Minérais et Métaux of Paris, in which Asturienne, Péchiney, and Penarroya are participating, has passed its dividend.

Earnings of the French-Yugoslavian Mines de Bor continue to shrink. In 1930 the earnings were 17,030,436 fr., against 50,689,540 fr. in 1929.

State action for subvention of the Norwegian copper producer, Röros, employing about 500 men, is still pending. The management contends that modernization of the plant on prospects of a general improvement in the world copper situation warrants such help. The proposed State aid is to take the form of a guaranteed loan. About 700,000 fr. of public funds has already been put into the property.

Otavi, a South African lead and copper property, is about to cease operations. In connection with African copper, there is some speculation in German metal circles as to just why the Katanga officials found it necessary to deny the rumor that the company is to curtail operations.

Negotiations for again establishing a world zinc cartel have been resumed in Brussels under the leadership of M. de Sincay, of Vieille Montagne. Belgium, Poland, Germany, and France were represented at the preliminary meetings. At the next meeting of the zinc group, to be held in July, Canadian, Mexican, and Australian producers are to be invited to attend. According to reports, a reduction in zinc output of about 45 per cent will be proposed. Promotors of the plan are making every effort to induce the Consolidated Mining & Smelting Company of Canada to join the cartel.

The members of the European aluminum cartel apparently are holding to the agreement to curtail production and stabilize prices. Montecatini, the Italian producer, reports that sales during the first five months of the current year are about equal in volume to the business booked in the same period last year. Recent purchases of aluminum by Russia at concessions have caused some dissatisfaction among German consumers. Russian advices state that plans are being made for an aluminum plant, of 75,000 tons' capacity, to be erected at Sagliski, on the Spak River.

The Italian quicksilver producer, Monte Amiata, is said to be suffering from an accumulation in stocks. This is ascribed as the chief cause of the recent downward revision in prices.

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Financial Notes

MINES DE VILLEMAGNE, French zinc-lead producer, subsidiary of Mining Trust, reports a loss of 6,684,818 fr. in 1930, compared with a loss of 4,388,585 fr. in 1929. The company has a total of 11,071,230 fr.

ETAINS DE KINTA, Belgian-controlled tin producer, reports a net profit of 757,724 fr. in 1930, compared with 2,701,067 fr. in 1929. Production in 1930 was valued at 9,073,269 fr.

COMPAGNIE ROYALE ASTURIENNE DES MINES, French-controlled zinc-lead producer, with properties in Spain, Tunis, Morocco, and Norway, reports an operating profit of 55,666,106 fr. in 1930. After general expenses, depreciation, and other charges, net profit was only 468,280 fr. The company has total assets of 715,493,678 fr., including 264,394,328 in accounts payable.

U. S. Zinc Stocks Reduced 4,121 Tons in June

Stocks of zinc at the end of June amounted to 138,928 tons, a decrease of 4,121 tons contrasted with the figures of a month ago. According to the American Zinc Institute, production declined for the third consecutive month. The reduction in zinc output during June was 2,205 tons, production for the month being 23,483 tons, the lowest since the beginning of the depression. Output in the United States during June of last year was 43,458 tons, though January, 1930, is credited with a production total of 52,010 tons.

Shipments in June totaled 27,604 tons, an increase of 1,753 tons compared with May. Unfilled orders at the end of the month increased from 31,146 tons in May to 33,086 tons in June.

The monthly statistics of the American Zinc Institute, in tons, follow:

	May	June
Production	25,688	23,483
Production, daily average	829	783
Shipments	(a) 25,851	27,604
Stock, end of month	143,049	138,928
Retorts operating end of month	23,024	21,422
Retorts operating, average for month	23,032	22,298
Unfilled orders	31,146	33,086

(a) Includes 20 tons exported during the month. There were no exports in June.

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Industrial Classification of Lead Shipments

Industrial classification of domestic lead shipments for March, April, and May, according to the American Bureau of Metal Statistics, in tons, follows:

	March	April	May
Cable	9,109	9,175	8,433
Ammunition	5,517	3,722	1,609
Tin foil	861	1,798	510
Batteries	2,182	2,684	3,762
Brass-making	111	263	176
Sundries	2,598	2,119	1,817
Jobbers	261	229	228
Unclassified (a)	16,122	15,344	17,546
Totals	36,761	35,324	34,081

(a) Of the shipments reported as unclassified, about one-third moves normally into white lead and about 30 per cent into red lead and litharge, as averages, but it is impossible to make a monthly segregation of the shipments according to these destinations. Other important manufactures are sheet and pipe, solder, and babbitt metal.

World Production of Copper

(American Bureau of Metal Statistics)

Copper production of the world during May was at the rate of 4,209 tons daily, against 4,296 tons in April, and 4,951 tons in May, 1930. The daily rate for the first five months of the year was 4,334 tons, comparing with 4,950 tons daily for all of last year. Copper production for the first five months of 1931, based on copper content of blister, as reported by smelters, without segregation according to countries of origin, in short tons, follows:

	Jan.	Feb.	March	April	May
United States	53,429	55,229	57,922	52,085	53,734
Mexico	4,489	4,149	4,094	3,799	4,078
Canada	8,852	9,408	9,228	9,625	9,000
Chile and Peru	24,064	24,124	24,551	24,613	24,812
Japan	7,003	7,190	7,041	7,334	7,230
Australia	300	1,218	1,946	435	1,873
Germany	5,353	5,067	6,276	5,886	4,459
Other Europe (a)	12,500	11,300	12,600	12,300	12,300
Elsewhere (b)	13,400	11,000	13,300	12,800	13,000
World's total	129,390	128,685	136,958	128,877	130,486

(a) Partly estimated. Includes production of blister copper in countries other than Germany, whereof Spain, Russia, Yugoslavia and Great Britain are the more important. (b) Chiefly Africa; partly estimated.

The irregularity of the monthly totals for Australia is ascribable to the intermittent operation of two of the smelters there.

World Silver Production Higher in April

During May the United States produced 2,532,000 oz. of silver, against 2,831,000 oz., in April, and 4,293,000 oz. in May, 1930, according to the American Bureau of Metal Statistics.

Canada produced 1,836,000 oz. of silver during May, against 1,139,000 oz. in the previous month, and 1,585,000 oz. in May of last year.

Production of silver in Peru also gained moderately over the April total, the output for May being estimated at 1,389,000 oz., against 1,215,000 oz. in the preceding month.

Australian production showed little change, the May output amounting to 638,000 oz.

Production statistics for Mexico and Burma for May have not yet been released. Mexico, during April, is credited with an output of 9,567,000 oz., against 6,511,000 oz. in March, and 7,514,000 oz. in April, 1930. Output of silver in Burma during April was estimated at 530,000 oz.

World production (about 87 per cent of total) for April, the latest month for which complete statistics are available, was 15,965,000 oz., against 13,745,000 oz. in March. World production for the first four months of the current year totaled 60,163,000 oz., against 72,046,000 oz. in the same time last year.

Silver production, in thousands of ounces, during March, April, and May, follows:

	March	April	May
United States	3,528	2,831	2,532
Canada	1,431	1,139	1,836
Mexico	6,511	9,567	(a)
Peru	1,056	1,215	1,389
Australia	689	683	638
Burma	530	530	(a)
	13,745	15,965	.....

(a) Not yet available.

■

ANGLO-ORIENTAL MINING, which has widespread interest in the tin-mining industry of the British Empire, reports a net profit of £34,379 in the year ended Feb. 28, 1931. In the previous year, profit was £96,466. The company received £48,315 in dividends, interest, commission, and net profit on investments. The company had a balance of £116,422 to carry forward on Feb. 28, 1931, and net assets of £2,029,889, of which £1,570,673 represented investments.

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Mining Company Dividends for June, 1931

Companies in the United States	Situation	Per Share	Total Disbursements
American Metal, 6% pfd	Various	$1.50 Q	103,014
American Smelting & Refining, 6% pfd	Various	1.50 Q	262,500
American Smelting & Refining, 7% pfd	Various	1.75 Q	875,000
Bunker Hill & Sullivan, s, l	Idaho	0.25 M	122,625
Eureka Standard, g, s	Utah	0.03 Q	45,000
Federal Mining & Smelting, pfd	Idaho, Oklahoma	1.75 Q	126,000
Freeport Texas Sulphur	Texas	0.75 Q	547,337
Golden Cycle, g	Colorado	0.40 Q	66,000
Granite Gold Mining	Colorado	0.01 Q	16,500
Hecla Mining, l, s	Idaho	0.10 Q	100,000
Homestake Mining, g	S. Dakota	0.50 M	125,800
Mayflower Associates, h	Various	0.50 Q	136,500
National Lead	Various	1.75 Q	426,433
National Lead, pfd. "A"	Various	1.75 Q	426,433
Nevada Consolidated Copper	Nev., Ariz., N. M.	0.25 Q	1,214,312
St. Joseph Lead	Various	0.25 Q	487,882
Tennessee Corporation, c	Tennessee	0.12½Q	198,656
Texas Gulf Sulphur	Texas	0.75 Q	1,905,000
Tintic Standard Mining, s, l	Utah	0.10 Q	115,332
Utah Copper	Utah	1.50 Q	2,434,493
Companies in Other Countries			
Chile Copper	Chile	0.37½Q	1,655,813
Hollinger Consolidated Gold	Ontario	0.05 Q	246,000
International Nickel, n, c	Ontario	0.15 Q	1,768,297
Lake Shore, g	Ontario	0.60 QB	600,000
McIntyre-Porcupine	Ontario	0.25 Q	199,500
Total			$14,165,283

s, silver; l, lead; c, copper; n, nickel; g, gold; q, quicksilver; h, holding company; Q, quarterly; M, monthly; B, plus bonus of 30c.

World Lead Production Reduced in May

World production of lead during the month of May declined sharply, reflecting the world-wide movement toward further curtailment in output. The daily rate for May was 3,979 tons, against 4,398 tons in April, and 4,693 tons in March. In May of last year the daily rate was 5,073 tons. All of the important producing countries except the United States registered losses in output. The gain in United States production was not regarded as significant, as the increase resulted largely from a cleaning-up process at some of the smelters preparatory to a period of lessened activity over the summer months.

Production of lead in May for all countries except the United States amounted to 83,820 tons, against 96,428 tons in the preceding month, and 103,714 tons in March. Production of 39,519 tons in the United States during May was below the monthly average of the first four months of the year.

World production, by countries, according to the American Bureau of Metal Statistics, follows:

(In Short Tons)

	March	April	May
United States	41,775	35,498	39,519
Canada	12,659	13,336	11,345
Mexico	24,801	22,207	18,426
Peru	.....	.....	.....
Germany	11,112	8,591	7,918
Italy	2,244	2,136	2,302
Spain and Tunis (a)	10,014	9,253	7,102
Europe (b)	17,600	17,500	15,700
Australia	16,412	14,533	13,129
Burma	7,672	7,672	6,698
Elsewhere (c)	1,200	1,200	1,200
	145,489	131,926	123,339

(a) Partial. (b) Not elsewhere specified and either estimated or partly estimated. (c) Estimated.

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Receipts of Lead in Ore

Receipts of lead in ore by United States smelters during May amounted to 36,367 tons, against 35,724 tons in April and 51,998 tons in May last year. Receipts of lead in scrap—inclusive only of scrap smelted in connection with ore—amounted to 2,506 tons during May, against 3,674 tons in the preceding month, and 1,717 tons in May, 1930, according to the American Bureau of Metal Statistics.

Receipts of lead in ore for the first five months of the year, in short tons, follow:

	Domestic	Foreign	Total
January	42,110	2,202	44,312
February	35,512	1,232	36,774
March	37,878	1,278	39,156
April	34,694	1,030	35,724
May	35,677	690	36,367

Receipts of lead in ore are computed on the basis of recoverable lead.

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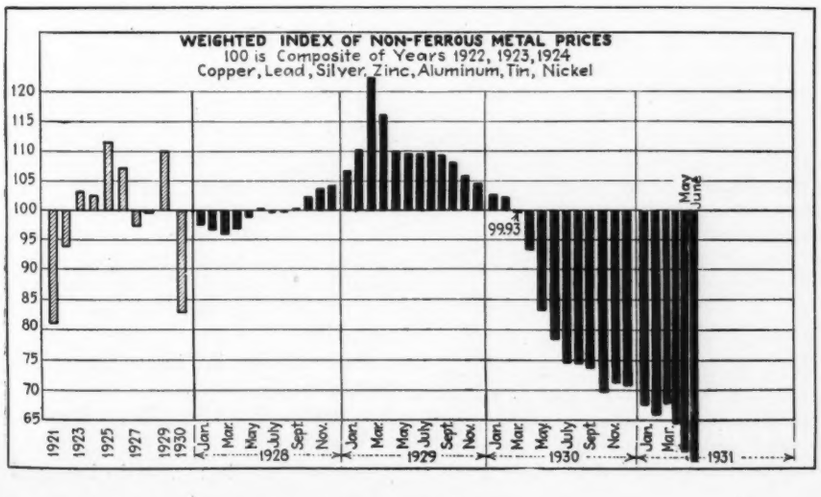
LAUTARO NITRATE COMPANY has passed the 7 per cent cumulative preference dividend due at this time. The step was taken with the object of conserving cash reserves.



Intergovernmental Debt Proposal Sends Prices for Metals Higher

New York, July 9, 1931.—The market for non-ferrous metals drifted along aimlessly until June 20, the day that President Hoover's proposal to suspend intergovernmental debt payments for a year was made public. This announcement started a heavy buying movement in all of the important security and commodity markets, and prices moved upward sharply. In copper, pronounced foreign and domestic activity sent the price up to 9c. Lead and zinc also advanced, though a gradual change for the better in the outlook for these metals contributed to the firmer views entertained by sellers. Tin scored a net gain of about 2c. per pound. Silver strengthened on the general advance in commodity prices. During the last week of the period the markets quieted down considerably, and copper, tin, and silver lost some of the ground gained after the debt proposal was announced. In the division for minor metals, interest centered in quicksilver, the price declining on increased offerings of domestic material.

Copper Fails to Hold Gains

Shortly before the debt moratorium proposal was announced in Washington, copper sold down to 7.75c. per pound, delivered Connecticut, a new all-time low. In the calendar week beginning June 22 the market became quite animated, and during this period upward of 50,000 tons of copper was sold to domestic consumers. Foreign buyers also bought a large tonnage, and prices advanced sharply, moving up to the basis of 9c. per pound. The delay in arriving at an agreement with France on the debt plan brought out general unsettlement in financial and commodity markets, and, so far as copper was concerned, the price eased off until the 8c. basis was again established on actual business. On July 8 copper sold at 8c., Connecticut basis, for delivery as far off as December.

Foreign sales for the month of June amounted to 77,000 long tons, against 22,300 long tons during May. Copper Exporters, Inc., announced the following price changes during the period under review: June 23, 8.525c.; June 24, 8.775c.; June 25, 9.025c.; June 29, 9.275c.; July 8, 8.775c., c.i.f. usual European ports. Foreign demand since the first of the current month has been dull.

Brass and wire mills enjoyed a period of good buying for just about a week after the debt announcement was made, but since then demand has again quieted down.

Prospects of another gain in stocks of refined copper did not help the market, especially in the last few days. Efforts were made to bring producers together to discuss further curtailment in production. Several informal meetings took place, but nothing constructive was accomplished. Some operators believe that negotiations may again be resumed, unless general business improves soon.

Lead Steady

In the last three weeks the price of lead advanced from 3.75c. to 4.40c., New York, and from 3.60c. to 4.225c., St. Louis. Two factors brought out the improvement in the lead market, one being the movement to further restrict output and the other the developments in connection with the war debts.

Sales made during June amounted to slightly more than 56,000 tons of virgin metal, an excellent record. Sales reported for June shipment amounted to about 36,800 tons, against 31,200 tons in the preceding month. The sales for June shipment attracted wide interest, as the total for the period was actually a little greater than the May intake of United States smelters. The total intake of lead in ore during that month was 36,367 tons, indicating that a balance between production and consumption has virtually been achieved.

The Lead Producers' Association, London, has announced that production in all countries except the United States has been further curtailed by 5 per cent, effective July 1. This latest move, coming just two months after the announcement of a 15 per cent reduction in output, is expected to suffice to bring production below the present rate of consumption.

Zinc at 3.90c.

Demand for zinc was fair, and prices advanced steadily, prompt and July Prime Western settling at 3.90c. per pound, St. Louis basis, a net gain for the period of 60 points. The strength in the market was attributed more to the reluctance of producers to sell than to the extent of the buying.

The zinc statistics, given in detail elsewhere in this issue, were better than expected, showing a decrease in stocks and production and an increase in consumption. Improvement in the statistical position of High-Grade zinc is said to be especially notable. Judging by the firmness in the price of zinc, the stocks, although large, seem to be in strong hands, and production has for the last eight months been kept in line with consumption.

Tin Higher

Price fluctuations in tin were largely in sympathy with the general movement in metal prices. Business was fair, and on good support from the foreign tin group the market held most of the gains.

Average Metal Prices for June, 1931

COPPER:	
Electrolytic, refinery	8.025
London Standard Spot	35.827
London Electrolytic, Bid	38.966
LEAD:	
New York	3.917
St. Louis	3.761
London Spot	11.582
London Forward	11.952
SILVER:	
New York	27.250
London	12.707
Sterling Exchange	486.291
ZINC:	
St. Louis	3.416
London Spot	11.270
London Forward	11.750
TIN:	
Straits	23.478
London Standard Spot	104.966
QUICKSILVER	92.058
ANTIMONY	6.342
PLATINUM, Refined	37.115
CADMIUM	55.000
ALUMINUM, 99 Per Cent Plus	23.300

Operators abroad feel that the curtailment plan will soon make an impression on the statistics and are inclined to take a favorable view of the market. The so-called world's visible supply on the last day of June was estimated at 51,626 long tons, against 51,231 long tons a month previous.

Silver Advances

Silver made a net gain of 2c. per ounce in the last three weeks, following the general upward movement in commodity markets. Covering by shorts was a factor in raising the price to 29¼c., New York, on July 3. On the advance, however, offerings increased, especially from China, and the market closed barely steady at 28⅝c.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 6.95c.; futures, 6.75c. After advancing sharply, business turned quiet and the prices toward the close were unsettled. Cookson's "C" grade, spot, 12c. "CMC" grade, 99.9 per cent, spot, 11c.

BISMUTH—Per lb., in ton lots, $1.50. London, 5s. 6d.

CADMIUM—Per lb., 55c. London, 1s. 9d.@1s. 10d.

COBALT—Per lb.: Metal imported

Daily Prices of Metals

June / July	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
18	7.775	22.75	3.75	3.60	3.35
19	7.55	23.10	3.75	3.60	3.35
20	7.725	23.15	3.75	3.60	3.475@3.50
22	7.775	24.00@24.10	3.935	3.815	3.40 @3.55
23	8.025	24.05	4.15	3.975	3.45 @3.55
24	8.275	24.125	4.25	4.075	3.50 @3.60
Av'ge	7.854	23.538	3.931	3.778	3.452
25	8.35	24.875@25.40	4.40	4.225	3.50@3.60
26	8.525	25.00 @25.625	4.40	4.225	3.60@3.65
27	8.525	26.50 @26.75	4.40	4.225	3.70
29	8.775	26.00 @26.625	4.40	4.225	3.85
30	8.275@8.775	25.25	4.40	4.225	3.90
1	8.025@8.275	25.25 @25.625	4.40	4.225	3.90
Av'ge	8.475	25.679	4.400	4.225	3.754
2	8.025@8.775	26.25	4.40	4.225	3.90
3	8.025@8.525	26.50	4.40	4.225	3.90
4			Holiday		
6	8.025@8.275	26.40	4.40	4.225	3.90
7	7.95	25.875	4.40	4.225	3.90@3.95
8	7.775	25.30	4.40	4.225	3.90
Av'ge	8.110	26.065	4.400	4.225	3.905

Average prices for calendar week ended June 20, 1931, are Copper, 7.738c.; Straits Tin, 22.888c.; New York lead, 3.750c.; St. Louis lead, 3.600; Zinc, 3.377c.; Silver, 26.667c.

Average prices for calendar week ended June 27, 1931, are Copper, 8.246c.; Straits tin, 24.883c.; New York ead, 4.256c.; St. Louis lead, 4.090c.; Zinc, 3.567c.; Silver, 28.833c.

Average prices for calendar week ended July 4, 1931, are Copper, 8.425c.; Straits tin, 25.950c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.890c.; Silver, 29.275c.

Silver, Gold and Sterling Exchange

June	Sterling Exchange "Checks"	Silver		Gold London	June July	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
18	4.86 5/16	26 5/8	12 3/8	84s 11 1/2d	29	4.86 3/16	29 1/8	13 3/4	84s 9 3/4d
19	4.86 1/4	26 3/4	12 7/16	84s 11 1/2d	30	4.86 3/16	29 1/8	13 1/2	84s 9 1/4d
20	4.86 5/16	26 7/8	12 1/2	.....	1	4.86 1/8	29 1/8	13 9/16	84s 11d
22	4.86 7/16	28 7/8	13 13/16	84s 11 1/4d	2	4.86 1/8	29 1/4	13 9/16	84s 11 1/4d
23	4.86 9/16	28 1/4	13 1/4	84s 10 1/2d	3	4.86 5/16	29 3/4	13 3/4	84s 10 3/4d
24	4.86 3/8	28 5/8	13 3/8	84s 11d	4	Holiday	Holiday	13 11/16	.....
25	4.86 3/8	28 7/8	13 7/16	84s 11d	6	4.86 5/16	29 3/8	13 9/16	84s 10 3/4d
26	4.86 1/4	28 7/8	13 7/16	84s 11d	7	4.86 7/16	29 3/8	13 5/8	84s 10 1/4d
27	4.86 1/4	29 1/2	13 11/16	.....	8	4.86 7/16	28 5/8	13 5/8	84s 10 3/4d

Average for week ended June 24: Silver, 27.667c.; Sterling Exchange, $4.86375c.
Average for week ended July 1: Silver, 29.104c.; Sterling Exchange, $4.86229.
Average for week ended July 8: Silver, 29.275c.; Sterling Exchange, $4.86325.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables commanded three-sixteenths cent premium on Jan. 7, 1931.

London

June / July	Copper Standard		Electrolytic	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
18	33 9/16	34 1/4	37	101 1/2	103	11 1/8	11 1/2	11 1/16	11 9/16
19	33 1/2	34 3/16	36 3/4	104 1/2	106 1/2	10 15/16	11 5/16	11 1/8	11 5/8
22	36 1/8	36 3/4	38 1/4	108 1/4	110 1/8	12	12 7/16	12 3/8	12 11/16
23	37 1/2	38 7/16	39 1/4	108 7/8	110 1/2	12 7/8	13 1/4	12 7/8	12 13/16
24	37 5/8	38 1/4	40 1/2	107 7/8	109 5/8	12 3/4	13 1/8	12 13/16	13
25	38 15/16	39 5/8	41 1/2	111 3/8	113 1/8	13 1/8	13 1/2	13	13 1/4
26	38 1/4	38 3/4	41	112 1/2	114 1/4	12 15/16	13 1/4	12 7/8	13 7/16
29	40 3/8	41	42 1/2	118 1/4	120 1/8	13 9/16	13 7/8	13 5/8	14
30	38 1/2	39	41 1/2	114 1/2	116	13 7/16	13 9/16	13 7/16	13 3/4
1	36	36 5/8	40 1/2	113 1/8	115 1/8	13	13 3/8	12 9/16	13 1/8
2	37 7/8	38 1/2	41	117	118 1/4	13 1/4	13 5/8	12 15/16	13 1/2
3	36 15/16	37 9/16	39 3/4	117 1/8	118 7/8	13 5/16	13 11/16	13 3/16	13 13/16
6	37	37 3/4	39 3/4	119	120 3/4	13 1/4	13 5/8	12 7/8	13 1/2
7	36 1/2	37 1/8	39 1/2	117 5/8	119 1/2	13 3/8	13 3/4	12 13/16	13 3/8
8	35	35 5/8	38 1/2	113 1/4	115	12 13/16	13 1/8	12 1/8	12 3/4

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

from Belgium, 97@99 per cent, $2.50 less 35 per cent for cash. On contract for yearly requirements usual rebate of 5 to 10 per cent, as to quantity. London quotes 9s., subject to usual discounts.

IRIDIUM—Per oz., $100@$105 for 98@99 per cent sponge and powder.

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £170 @£175, as to quantity.

PALLADIUM—Per oz., $19@$21. London, £3 12s. 6d.@£4.

PLATINUM—Per oz. Official price of leading interest, $40. Cash transactions between dealers and refiners at about $2 less. London official price £8. *Correction*—London price in issue of June 22 should have been £8 and not £5 2s. 6d.

QUICKSILVER — Per 76-lb. flask. $85@$90. Business was extremely quiet and quotations again eased off on rather liberal offerings. London quotes £16 19s.@£17.

Chromium, Magnesium, Manganese, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Silicon, Tantalum, Tellurium, Thallium, and Tungsten are unchanged from prices given in the June 22 issue.

Metallic Ores

Prices in tons of 2,000 lb., or in "Units" of 20 lb., unless otherwise stated.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17 for 46@48 per cent Cr_2O_3 ore, and $19.50@$20 for 50@51 per cent ore. London, 75s. for 48 per cent Rhodesian, and 77s. 6d.@ 87s. 6d. for Indian and New Caledonian.

IRON ORE—Per long ton unit, foreign ores alongside docks Atlantic ports, cargo lots, North African low phosphorus, 8½@9c.; Swedish, 9½c. Spanish and North African basic, 50 to 60 per cent, 9c. Other prices in June 22 issue.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty of 1c. per lb. of Mn contained: Indian, 48 to 50 per cent, 26@27c., nominal; South African, 52 to 54 per cent, 25@26c.; 50 to 52 per cent, 24@25c.; 44 to 46 per cent, 23½c. Caucasian, 52@55 per cent, 25@26c.

TUNGSTEN ORE—Per unit of WO_3, New York: Chinese wolframite, duty paid, $11.25. Bolivian scheelite, $11.25 @$11.50; domestic scheelite, $12. Nominal.

Antimony, Beryllium, Molybdenum, Tantalum, Tin, Titanium, Vanadium, and Zircon ores are unchanged from prices given in the June 22 issue.

Non-Metallic Minerals

Non-metallic mineral quotations are unchanged from those given in the issue of June 22.

Metal Statistics

Monthly Average Prices of Metals

(See daily price table for basis of quoting)

Silver

	New York		London Spot		Sterling Exchange	
	1930	1931	1930	1931	1930	1931
January	45.000	29.423	20.896	13.810	486.447	485.260
February	43.193	26.773	20.008	12.432	485.784	485.551
March	41.654	29.192	19.298	13.524	485.933	485.596
April	42.428	28.279	19.554	13.120	486.019	485.764
May	40.736	27.650	18.850	12.858	485.724	486.188
June	34.595	27.250	16.049	12.707	485.625	486.291
July	34.346	.....	15.928	.....	486.300	.....
August	35.192	.....	16.283	.....	486.839	.....
September	36.315	.....	16.738	.....	485.888	.....
October	35.846	.....	16.563	.....	485.719	.....
November	35.908	.....	16.625	.....	485.454	.....
December	32 635	.....	15 201	.....	485.413	.....
Year	38 154	.....	17.666	.....	485.929	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery Electrolytic		London Spot Standard		London Spot Electrolytic	
	1930	1931	1930	1931	1930	1931
January	17.775	9.838	71.469	44.938	83.250	47.524
February	17.775	9.724	71.419	45.372	83.500	47.950
March	17.775	9.854	69.202	44.818	83.405	47.699
April	15.621	9.392	62.075	42.694	74.338	45.375
May	12.756	8.665	53.159	38.897	59.545	42.175
June	12.049	8.025	50.003	35.827	56.750	38.966
July	11.023	.....	48.277	.....	52.522	.....
August	10.693	.....	47.525	.....	50.725	.....
September	10.310	.....	46.264	.....	49.500	.....
October	9.597	.....	43.030	.....	45.772	.....
November	10.113	.....	46.134	.....	48.963	.....
December	10.300	.....	46.771	.....	50.065	.....
Year	12.982	.....	54.611	.....	61.528	.....

New York quotations, cents per pound. London, pounds sterling per long ton

Lead

	New York		St. Louis		London			
	1930	1931	1930	1931	1930 Spot	1930 3 Mos.	1931 Spot	1931 3 Mos.
January	6.250	4.802	6.100	4.604	21.545	21.571	13.872	13.905
February	6.236	4.552	6.086	4.340	21.188	21.097	13.444	13.550
March	5.662	4.527	5.542	4.276	18.807	18.940	13.128	13.355
April	5.537	4.412	5.428	4.164	18.319	18.363	12.375	12.606
May	5.523	3.818	5.408	3.651	17.795	17.861	11.491	11.778
June	5.410	3.917	5.310	3.761	17.941	17.994	11.582	11.952
July	5.250	.....	5.149	.....	18.160	18.063	.....	.....
August	5.488	.....	5.340	.....	18.294	18.178	.....	.....
September	5.500	.....	5.348	.....	17.909	17.798	.....	.....
October	5.151	.....	4.999	.....	15.747	15 674	.....	.....
November	5.100	.....	4.950	.....	15.934	15.931	.....	.....
December	5.100	.....	4.950	.....	15.283	15.292	.....	.....
Year	5.517	.....	5.384	.....	18.077	18.064	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin and Cadmium

	New York		London		Cadmium
	1930	1931	1930	1931	1931
	Straits		Spot		
January	38.851	26.137	175.466	115.798	67.115
February	38.676	26.315	173.750	117.919	55.000
March	36.798	27.065	164.851	121.852	55.000
April	36.077	25.222	162.638	112 775	55.000
May	32.108	23.221	144.818	104.331	55.000
June	30.336	23.478	136.300	104.966	55.000
July	29.822	.....	134.511	.....	.....
August	30.044	.....	134.988	.....	.....
September	29.647	.....	132.631	.....	.....
October	26.802	.....	117.451	.....	.....
November	25.904	.....	113.519	.....	.....
December	25.262	.....	111.560	.....	.....
Year	31.694	.....	141.873	.....	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St Louis		London			
	1930	1931	1930 Spot	1930 3 Mos.	1931 Spot	1931 3 Mos.
January	5.229	4.035	19.634	20.241	12.747	13.113
February	5.180	4.012	19.209	19.778	12.303	12.694
March	4.934	4.002	18.304	18.810	12.190	12.676
April	4.843	3.717	17.819	18.378	11.353	11.838
May	4.641	3.306	16.639	17.330	10.484	10.875
June	4.441	3.416	16.422	17.038	11.270	11.750
July	4.350	.....	16.171	16.777	.....	.....
August	4.360	.....	15.953	16.469	.....	.....
September	4.279	.....	15.773	16.080	.....	.....
October	4.059	.....	14.446	14.935	.....	.....
November	4.266	.....	14.706	15.238	.....	.....
December	4.099	.....	13.762	14.214	.....	.....
Year	4.556	.....	16.570	17.107	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1930	1931	1930	1931	1930	1931
January	8.606	7.317	121.192	103.000	61.923	36.000
February	8.830	7.069	120.500	100.205	59.909	34.000
March	8.236	7.127	118.808	100.423	54.769	29.538
April	7.740	6.888	114.000	102.077	46.462	26.346
May	7.454	6.524	117.269	101.140	46.000	24.980
June	7.057	6.342	118.600	92.058	46.000	37.115
July	6.976	.....	117.462	.....	43.692	.....
August	7.839	.....	116.000	.....	41.462	.....
September	7.773	.....	113.620	.....	36.080	.....
October	7.288	.....	110 596	.....	36.000	.....
November	7.105	.....	106.717	.....	36.000	.....
December	7.099	.....	105.346	.....	36.000	.....
Year	7.667	.....	115.009	.....	45.358	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1930	1931	1930	1931	1930	1931	1930	1931
Jan	19.00	17.50	18.50	17.00	18.50	17.00	24.300	23.300
Feb	19.00	17.29	18 50	16.79	18.50	16.79	24.300	23.308
March	19.00	17.00	18 50	16.50	18 50	16.50	24.300	23.300
April	19 00	17.00	18 50	16.50	18.50	16.50	24.300	23.300
May	19.00	17.00	18.50	16.38	18.50	16.44	24.300	23.300
June	19 00	17.00	18 50	15. 50	18.50	16.00	24.140	23.300
July	18.62	.....	18 12	.....	18.12	.....	23.300	.....
Aug	18.50	.....	18 00	.....	18 00	.....	23.300	.....
Sept	18.38	.....	17 76	.....	17 88	.....	23.300	.....
Oct	17.85	.....	17 00	.....	17 22	.....	23.300	.....
Nov	17. 50	.....	17.00	.....	17.00	.....	23.300	.....
Dec	17 50	.....	17 00	.....	17.00	.....	23.300	.....
Year	18 53	.....	17 99	.....	18.02	.....	23.787	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76

Monthly Crude Copper Output in Short Tons

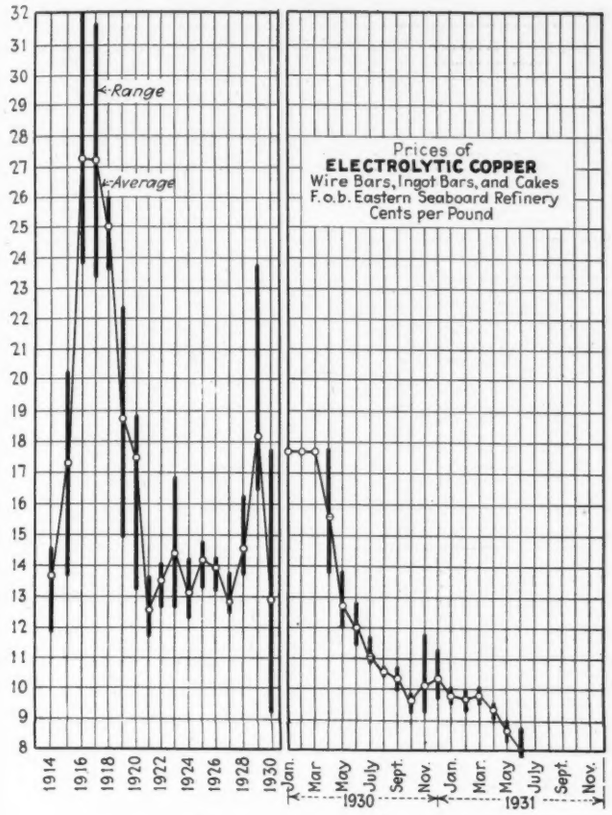
	1929 Total	1930 Total	1931 Feb.	1931 Mar.	1931 Apr.	1931 May
Domestic						
Alaska shipments	21,947	18,953	627	563	885	1,215
Calumet & Arizona	65,246	45,161	3,237	3,189	.....	.....
Magma	19,118	15,940	1,202	1,223	1,213	1,208
Miami	29,567	34,568	1,745	2,025	1,995	2,272
Nevada Cons	133,140	70,990	.....	(d) 16,4 3	.....	.....
Old Dominion (a)	11,172	10,428	576	580	587	992
Phelps Dodge (b)	111,026	72,308	5,184	5,188	5,180	5,176
United Verde Extens	29,669	21,908	1,610	1,618	1,537	1,685
Tennessee Corp	7.870	7,772	585	611	609	992
Foreign						
Andes Copper	60,538	47,428	3,498	3,498	.....	.....
Braden	88,155	79,923	8,595	8,596	.....	.....
Boleo, Mexico	12,898	13,940	.....	(d) 3,250	.....	.....
Chile	150,247	89,100	7,117	7,117	.....	.....
Furukawa, Japan	17.767	18,536	1,542	1,563	1,624	.....
Howe Sound	21,516	22,633	.....	.....	.....	.....
Messina	(c) 7,200	.....	749	843	764	868
Mt. Lycll	9,731	10,878	.....	(d) 2,699	.....	.....
Sumitomo, Japan	20.180	15,429	1,129	1,400	1.236	1,571

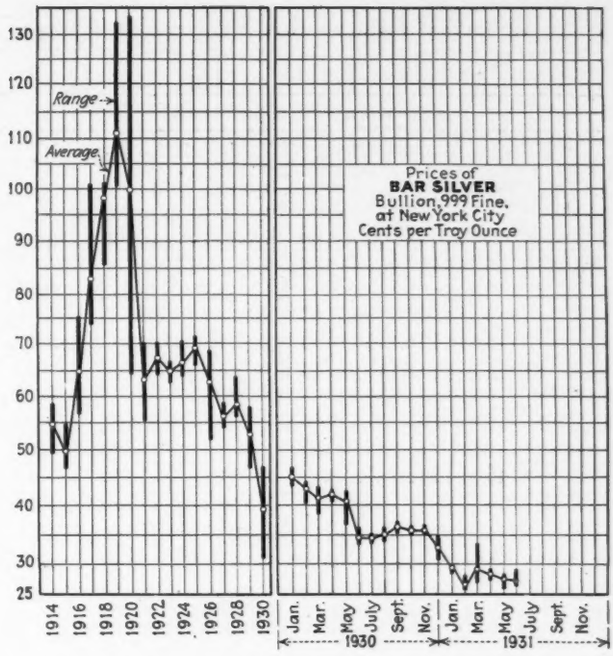
(a) Includes Arizona Commercial. (b) Moctezuma is included. (c) Estimated. (d) Three months.

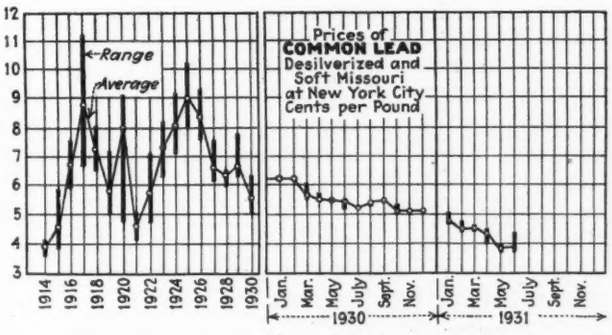
Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

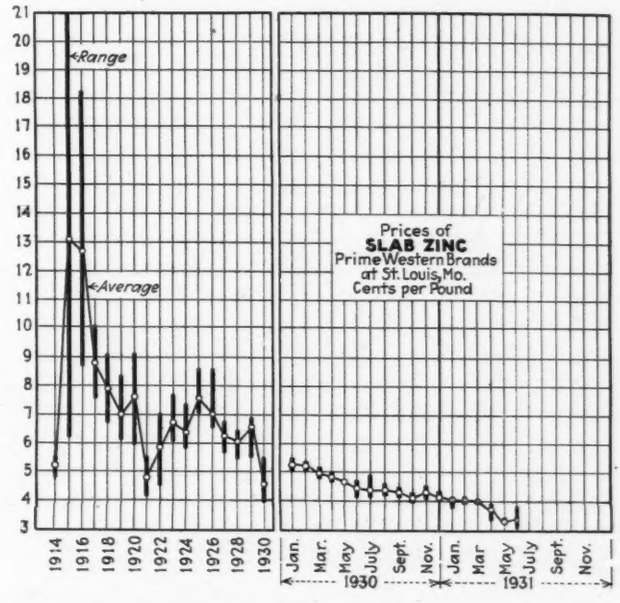
	1929 Monthly Production	1929 Daily Rate	1930 Monthly Production	1930 Daily Rate	1931 Monthly Production	1931 Daily Rate
January	86,324	2,785	67,838	2,188	48,059	1,550
February	84,735	3,026	59,196	2,114	47,504	1,697
March	93,698	3,023	61,216	1,975	48,702	1,571
April	94,902	3,163	60,450	2,015	46.452	1,548
May	93,392	3,013	60,238	1,943	45.671	1,473
June	82,354	2,745	56,743	1,891	.....	.....
July	79,229	2,556	54,249	1,750	.....	.....
August	78,885	2,545	56,779	1,832	.....	.....
September	79,402	2,647	56,584	1,886	.....	.....
October	82,575	2,664	55,954	1,805	.....	.....
November	75,934	2,531	53,141	1,771	.....	.....
December	74,772	2,412	48,518	1,565	.....	.....
Total	1,006,203	.....	690,263	.....	236,388	.....
Monthly average	83,850	.....	57,522	.....	47,270	.....
Av. of daily rate	.....	2,757	.....	1,891	.....	1,565

Metal Price and Production Curves

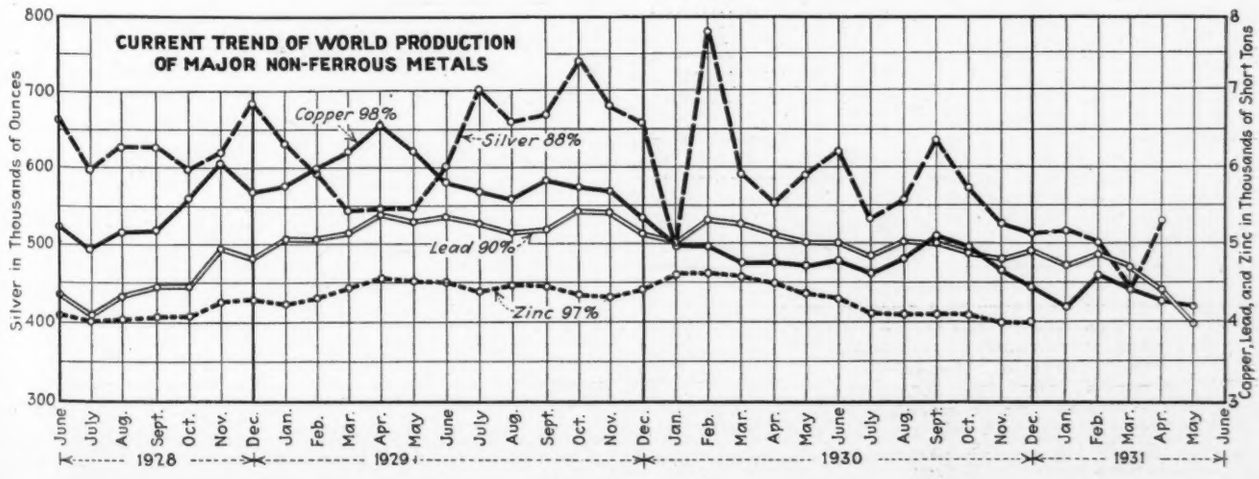








The curves below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output, according to the latest estimates of the American Bureau of Metal Statistics.


CURRENT TREND OF WORLD PRODUCTION
OF MAJOR NON-FERROUS METALS
Copper 98%
Silver 88%
Lead 90%
Zinc 97%
Silver in Thousands of Ounces
Copper, Lead, and Zinc in Thousands of Short Tons
June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June
1928
1929
1930
1931

Mining Share Prices—Month of June, 1931

Company Name	High	Low	Last	§Most Recent Dividend	
NEW YORK STOCK EXCHANGE					
Ahumada Lead	0.37½	0.12½	0.12½	April, 1927	0.12½
Alaska Juneau	20½	11½	12½	Ap. 10, My. 1, 1931 Q	0.10
American Metal	16½	8.12½	13½	December, 1930 Q	0.25
Am. Metal, pfd	53½	53½	53½	My. 21, Je. 1, 1931 Q	1.50
Am. Sm. & Ref	40⅜	24⅜	36⅛	Ap. 17, My. 31, 1931 Q	1.00
Am. Sm. & Ref. 2nd. pfd.	92½	83½	92	My. 8, Je. 1, 1931 Q	1.50
Am. Sm. & Ref., pfd	119	118½	118½	My. 8, Je. 1, 1931 Q	1.75
Am. Zinc., L. & S	6.75	3.75	6.00	May, 1917	1.00
Am. Zinc, L. & S., pfd.	40	27	40	October, 1930 Q	1.50½
Anaconda	32½	18½	28⅞	Ap. 11, My. 18, 1931 Q	0.37½
Andes Copper	10	9.00	13	Ja. 10, Fe. 9, 1931 Q	0.25
Butte C. & Z	1.00	0.75	1.00	December, 1929	0.50
Butte & Superior	2.50	1.12½	2.50	December, 1929 Q	0.50
Callahan Zinc-Lead	0.75	0.50	0.62½	December, 1920	0.50
Cal. & Arizona	39½	23½	36	June, 1930	0.50
Cal. & Hecla	8.75	5.00	7.50	June, 1930	0.50
Cerro de Pasco	24	14	20½	Ap. 16, My. 1, 1931 Q	0.50
Dome Mines	13½	11	11⅛	Mh. 31, Ap. 20, 1931 Q	0.25
Federal M. & S	40	30½	40	June, 1927	10.00
Federal M. & S., pfd			94*	My. 25, Je. 5, 1931 Q	1.75
Freeport Texas	30	22	28	My. 15, Je. 1, 1931 Q	0.75
Granby Con	17½	10	15½	Ja. 16, Fe. 2, 1931 Q	0.50
Greene Cananea			73½*	July, 1930	0.75
Homestake	91	83½	91	Je. 20, Je. 25, 1931 M	0.50
Howe Sound	22½	13	20⅞	Je. 30, Jy. 15, 1931 Q	0.50
Inspiration	9.75	4.12½	8.00	July, 1930	0.50
International Nickel	16½	9.50	15½	Je. 1, Je. 30, 1931 Q	0.15
Int. Nickel, pfd	118	112	117	Ja. 3, Fe. 2, 1931 Q	1.75
Kennecott	25⅜	14⅜	20⅛	Mh. 12, Ap. 1, 1931 Q	0.50
McIntyre-Porcupine	23⅞	20½	22	My. 1, Je. 1, 1931 Q	0.25
Magma Copper	18½	10½	16	Mh. 31, Ap. 15, 1931 Q	0.50
Miami Copper	8.25	4.50	7.25	August, 1930	0.375
Mother Lode	0.62½	0.37½	0.62½	June, 1930	0.10
National Lead	126½	85	122	Je. 12, Je. 30, 1931 Q	1.25
National Lead, pfd. A	143	140	141	My. 29, Je. 15, 1931 Q	1.75
National Lead, pfd. B	119	118	119	Jy. 17, Au. 1, 1931 Q	1.50
Nevada Con	12⅛	6.12½	10⅜	Je. 12, Je. 30, 1931 Q	0.25
Noranda Mines	22½	15½	19¼	October, 1930	0.50
Park Utah Con	1.62½	1.00	1.50	July, 1929 Q	0.20
Patiño M. & E	13½	6.00	12	December, 1929	4s.
Phelps Dodge	17½	11	15	De. 13, Ja. 2, 1931 Q	0.50
Rand Mines	26½	26½	26½	August, 1930	1.52
St. Joseph Lead	21¼	14½	20	Je. 9, Je. 20, 1931 Q	0.25
Seneca Copper	1.50	0.37½	1.50		
Tennessee Corp	7.75	5.12½	7.00	Fe. 28, Mh. 16, 1931 Q	0.125
Texas Gulf Sulphur	39½	29½	37½	Je. 1, Je. 15, 1931 Q	0.75
U. S. S. R. & M	20	15½	18	Ap. 2, Ap. 15, 1931 Q	0.25
U. S. S. R. & M., pfd	43	40	43	Ap. 2, Ap. 15, 1931 Q	0.875
Utah Copper	100	100	100	Je. 12, Je. 30, 1931 Q	1.50
Vanadium Corp	38⅛	23¼	36⅛	Fe. 2, Fe. 16, 1931 Q	0.75
NEW YORK CURB EXCHANGE					
Aluminum Co. of Am	146	90	133½		
Alum. Co. of Am., pfd	100	95	95½	Mr. 14, Ap. 1, 1931 Q	1.50
Anglo-Chilean Con	8.25	5.12½	8.00	4 shares Cosach B.	June, 1931
Bunker H. & S	40	24½	40	My. 29, Je. 5, 1931	0.25
Carnegie Metals	0.75	0.75	0.75		
Comstock Tunnel	0.62½	0.43½	0.62½		
Con. Coppermines	2.87½	2.00	2.50		
Copper Range			5.00*	July, 1930	0.25
Cresson Con	0.43½	0.37½	0.43½	Mh. 31, Ap. 10, 1931 Q	0.01
Cusi Mexicana	0.62½	0.37½	0.62½		
Evans-Wallower	1.00	0.50	0.75		
Federated Metals	8.25	7.50	8.12½	Ja. 5, Ja. 15, 1931 Q	0.25
Hecla Mining	6.00	4.00	6.00	Je. 30, Jy. 15, 1931 Q	0.10
Hollinger Con	7.12½	6.25	6.75	Je. 3, Je. 17, 1931 M	0.05
Hudson Bay M. & S	5.25	3.12½	5.00		
Iron Cap Copper			0.75*		
Mayflower Associates	34	25	34	Je. 1, Je. 15, 1931 Q	0.50
Mining Corporation	2.00	1.75	2.00	December, 1929	0.12½
New Jersey Zinc	40⅜	34⅜	40⅜	Ap. 20, My. 9, 1931 Q	0.50
Newmont Mining	36⅜	23½	35	Mh. 31, Ap. 15, 1931 Q	1.00
N. Y. and Honduras	11	10⅜	11	Ap. 14, Ap. 25, 1931 QX	0.50
Nipissing	1.12½	0.75	1.12½	Mh. 31, Ap. 20, 1931 Q	0.075
Ohio Copper	0.37½	0.12½	0.25	September, 1926	0.03
Premier Gold	0.75	0.62½	0.75	Mh. 13, Ap. 4, 1931 Q	0.03
Quincy	6.75	5.00	6.75	March, 1920	1.00
Shattuck Denn	5.00	3.00	4.25		
So. Am. Gold & Plat	2.12½	1.37½	1.62½		
Teck-Hughes	7.12½	6.25	6.75	Ap. 17, My. 1, 1931 Q	0.15
Tonopah Mining	0.62½	0.37½	0.50	October, 1929	0.07½
United Eastern			0.06½*		
United Verde Ex	12	5.50	9.50	Ap. 2, My. 1, 1931 Q	0.50
Utah-Apex	1.25	0.75	1.25	December, 1929	0.02½
Yukon Gold	0.31½	0.18½	0.18½	June, 1918	0.02
BOSTON STOCK EXCHANGE					
Isle Royale	4.00	3.00	3.50	March, 1930	0.50
Mohawk Mining	17⅜	15½	16	Ap. 30, My. 30, 1931 Q	0.25
Old Dominion	2.75	2.62½	2.62½	December, 1918	1.00
Utah Met. & Tunnel	0.40	0.26	0.30	December, 1927	0.30
MONTREAL					
Asbestos Corp	0.25	0.25	0.25	January, 1926	1.50
Asbestos Corp., pfd	0.50	0.50	0.50	January, 1930	1.75
Consolidated M. & S	115½	72	110	De. 30, Ja. 15, 1931 SAX	6.25
SPOKANE					
Constitution	0.06½	0.06½	0.06½		
Dayrock	0.95	0.75	0.95	March, 1930	0.03
Golconda	0.30	0.15½	0.27	July, 1929	0.02
Jack Waite Con	0.40	0.20	0.35		
Los Lugos			0.14½*		
Mexican Premier	0.12½	0.10½	0.12½	January, 1930	0.01
Montana Mines	0.15½	0.12	0.13½		
Noble Five			0.04½c	January, 1930	0.005
Pend Oreille			0.75c		
Sherman Lead			0.30c	March, 1930	0.01
Sidney			0.03c	October, 1929	0.01
Sunshine Mining	1.19	0.86	1.06	December 20, 1930 Q	0.03
Tamarack & Custer	0.20	0.19½	0.20	September, 1924	0.25
SALT LAKE CITY					
Chief Con	0.57	0.50	0.53	February, 1928	0.10
Combined Metals	0.08½	0.06½	0.08½		
Eureka Bullion	0.22	0.16	0.20½		
Eureka Lilly	0.16½	0.10½	0.16½		
Moscow Silver	0.35	0.25	0.35		
New Quincy	0.07	0.03½	0.06½	September, 1929 Q	0.10
North Lily	1.02½	0.83	0.97	January, 1930	0.15
Park Bingham	0.50	0.25	0.25		
Park City Con	0.18½	0.10	0.16		
Rico Argentine	0.05	0.02½	0.05	December, 1929	0.03
Silver King Coalition	4.75	3.40	4.50	De. 20, Ja. 2, 1931 Q	0.15
Tintic Lead	1.12½	0.99	1.07½		
Tintic Standard	4.00	3.10	3.75	Je. 20, Je. 30, 1931 Q	0.10
Walker Mining	1.65	1.00	1.00	April, 1930	0.075
¶ TORONTO					
Abana Mines	0.09½	0.05½	0.07½		
Amulet Mines	0.28	0.12	0.24		
Base Metals	1.15	0.75	1.15		
Barry-Hollinger	0.13	0.08	0.10		
Canam Metals	0.04	0.02½	0.02½		
Castle-Trethewey	0.17	0.15	0.16		
Central Manitoba	0.12	0.07	0.11		
Falconbridge	1.37	0.90	1.30		
Granada Rouyn	1.73	1.25	1.40		
Howey Mines	0.30	0.20	0.28		
Keeley	0.27	0.23	0.25	March, 1928	0.04
Kirkland Lake	0.68	0.60	0.66		
Lake Shore	26½	25½	26	Je. 1, Je. 15, 1931 QB	0.60
Sherritt Gordon	0.78	0.50	0.75		
Siscoe Gold	0.50	0.44	0.49		
Sylvanite	0.77	0.68	0.72	De. 5, De. 20, 1930 SA	0.02
Treadwell Yukon	1.55	1.55	1.55		
Ventures	0.55	0.41	0.54		
Vipond Con	0.90	0.77	0.82	April, 1927	0.03
Waite-A.-M	1.45	0.90	1.35		
Wright-Hargreaves	3.00	2.66	2.80	Mh. 14, Ap. 1, 1931	0.025
ST. LOUIS, CINCINNATI, AND DENVER					
Consolidated L. & Z	1.75	1.50	1.50	December, 1929	0.125
Eagle-Picher	5.50	4.37½	5.00	April, 1930	0.20
Eagle-Picher, pfd			89*	De. 31, Ja. 15, 1931 Q	1.50
Empire Chief					
Star of Utah					
Tungsten Prod					
West Gold					
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS					
California Copper	0.50	0.25	0.50		
(a) Golden Cycle	15	14	15	My. 31, Je. 10, 1931 Q	0.40
(a) Granite Gold	0.20	0.18	0.18	Mh. 27, Ap. 1, 1931 Q	0.01
Idaho-Maryland	0.66	0.43½	0.52		
Tom Reed	0.98	0.74	0.77	Mh. 16, Ap. 1, 1931	0.03
(a) United Gold	0.07½	0.07½	0.07½	February, 1930	0.01

‡LONDON

Company Name	High	Low	Last	Most Recent Dividend (Per Cent, Unless Noted)
Anglo American	12/1½	9/10½	11/3	22½, Feb. 19. 1930
Aramayo Mines	19/9	17/6	18/9	5, Oct. 23, 1929
Burma Corporation	7/10½	5/1½	7/7½	1½, Dec. 10. 1930(b)
Camp Bird	4/4½	2/9	4/–	16¾, April 25, 1928
Fresnillo	4½d.	2d.	3d.	25 cents, Feb. 12, 1930
Frontino & Bolivia	11/3	10/3	11/3	2½, July 1, 1931
Lake View & Star	9/3	7/6	9/–	11¼, 1921
Mexican Corporation	3/3	3/–	3/3	10, Oct. 24, 1929
Oroville Dredging	1/9	1/6	1/9	37½, May 16, 1930
Rhokana Corporation	98/1½	64/4½	95/–	
Rhodes.-Select. Trust	10/–	8/–	10/–	
Rio Tinto	382/6	285/–	360/–	10s, May 1, 1931
St. John del Rey	18/6	17/9	18/–	8¾, May 1, 1931
San Francisco Mines	9/9	7/6	9/6	10, Jan. 7, 1931
Santa Gertrudis	7/1½	5/7½	6/9	9d., July 9, 1931
Selukwe	2/–	1/3	2/–	6¾, April 2, 1917
So. American Copper	1/7½	1/2	1/6	
Tanganyika	22/6	16/9	21/3	7 2½, Aug. 2, 1930
Wiluna Gold	16/7½	13/6	16/6	
Union Minière	4,475	3,400	3,850†	240 francs, July, 1931

Salt Lake Stock Exchange courtesy J. A. Hogle & Company, Spokane Standard Exchange courtesy the Pohlman Investment Company. *Not traded in †Belgian Francs. ‡The above London quotations are for the month ended June 23. ¶Toronto prices are for the month ended June 27. Q, quarterly; I, initial; M, monthly; X, extra; SA, semi-annual; L, liquidating; B, plus bonus. §Total dividends paid during the month will be found tabulated in the Market and Financial News Section. Dates here given are those of closing of books and payment of dividend. (a) Bid prices. (b) 1¼% (2 annas) dividend, and bonus of ¼% (1 anna). (c) Closing bid prices.